02-8804-09-SI
REV. NO. 0

FINAL DRAFT
SITE INSPECTION REPORT
UNION CHEMICAL
CARTERET, NEW JERSEY

PREPARED UNDER

TECHNICAL DIRECTIVE DOCUMENT NO. 02-8804-09
CONTRACT NO. 68-01-7346

FOR THE

ENVIRONMENTAL SERVICES DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY

JUNE 27, 1989

NUS CORPORATION
SUPERFUND DIVISION

SUBMITTED BY

Diane Trube

DIANE TRUBE
PROJECT MANAGER

Glenn A. Calabrese

GLENN A. CALABRESE
SITE MANAGER

REVIEWED/APPROVED BY

Ronald M Naman

RONALD M. NAMAN
FIT OFFICE MANAGER

280446

SITE NAME:	Union Chemical	**EPA ID NO:**	NJD063173280
ADDRESS:	350 Roosevelt Avenue Carteret, New Jersey	**LATITUDE:**	40° 34′ 42″ N
		LONGITUDE:	74° 12′ 53″ W
		BLOCK:	6.01
		LOT:	8
		ACREAGE:	4.436

1.0 SITE SUMMARY

The Union Chemical Company is located on approximately 4.4 acres of land in Carteret Borough, Middlesex County, New Jersey. The facility is active and is in a heavily industrialized section of Carteret. The site is bounded by Noes Creek to the south, Roosevelt Avenue to the east, New Jersey Branch Railroad tracks to the west, and the Wheeler Condenser and Engineering Company to the north. The facility is owned and operated by Union Oil Company of California, aka American Mineral Spirits Company. The Benjamin Moore Company owned the property and operated there until 1962 when Union Chemical purchased the facility for bulk storage and repackaging. From 1969 to 1984, anhydrous ammonia was processed to ammonia. Presently, approximately 125 different products are handled at the facility, most of which are solvents.

The Union Chemical facility has had several spill releases to the environment since 1983. In June 1985, IT Corporation was retained by Union Chemical to conduct a site assessment. The purpose of this initial site assessment was to define the geologic and hydrogeologic conditions and to estimate the extent of possible groundwater contamination at the site. IT Corporation installed 18 monitoring wells on site, which are presently being tested quarterly by Union Chemical.

In 1988, Woodward-Clyde consultants were procured by Union Chemical Company to assist in the evaluation of a 1988 spill and to further assess the environmental conditions at the site. The Union Chemical owners have submitted a plan to the State for removal of contaminated soil. The plan is awaiting final approval.

An on-site reconnaissance was performed on March 7, 1989, by NUS Corp. Region 2 FIT. No sampling was performed by NUS Region 2 FIT since there are extensive data available.

Ref. Nos. 1, 2, 3, 4, 5, 6, 7, 9, 10, 14

2.0 SITE INSPECTION NARRATIVE

2.1 EXISTING ANALYTICAL DATA

This section will be divided into subsections, to present analytical data for each affected medium separately.

2.1.1 Groundwater

The groundwater data are from the quarterly testing of the wells by Union Chemical as directed by the State in January 1989. Refer to Figures A and B for the sample location map prepared by Woodward-Clyde and groundwater contour map prepared by IT Corporation. Table A summarizes relevant data.

Ref. Nos. 9, 11

2.1.2 Surface Water

Surface water samples were collected by IT Corporation in December 1986. One water sample was reportedly collected upstream (SW-1) and two downstream (SW-2 and a duplicate) of the site from Noes Creek. Noes Creek is tidal. Although sampling was conducted at ebb tide, apparently with the assumption that such conditions permitted an upgradient sample unaffected by the site, it has not been documented satisfactorily that such effects as eddy currents and re-entrainment of contaminated sediment can be discounted.

Parameter	SW-1 (values in ppb)	SW-2 (values in ppb)	SW-2 (duplicate) (values in ppb)
benzene	6.6	---	---
chlorobenzene	61	12	24
1,2-dichloropropane	200	98	83
ethylbenzene	9.1	---	---
tetrachloroethylene	12	6.2	7.6
toluene	14	13	12
1,1,1-trichloroethane	12	11	14
acetone	18	---	---
4-methyl-2-pentanone	41	14	14
total xylenes	80	19	27
methylene chloride	---	140	110

Ref. Nos. 11, 14

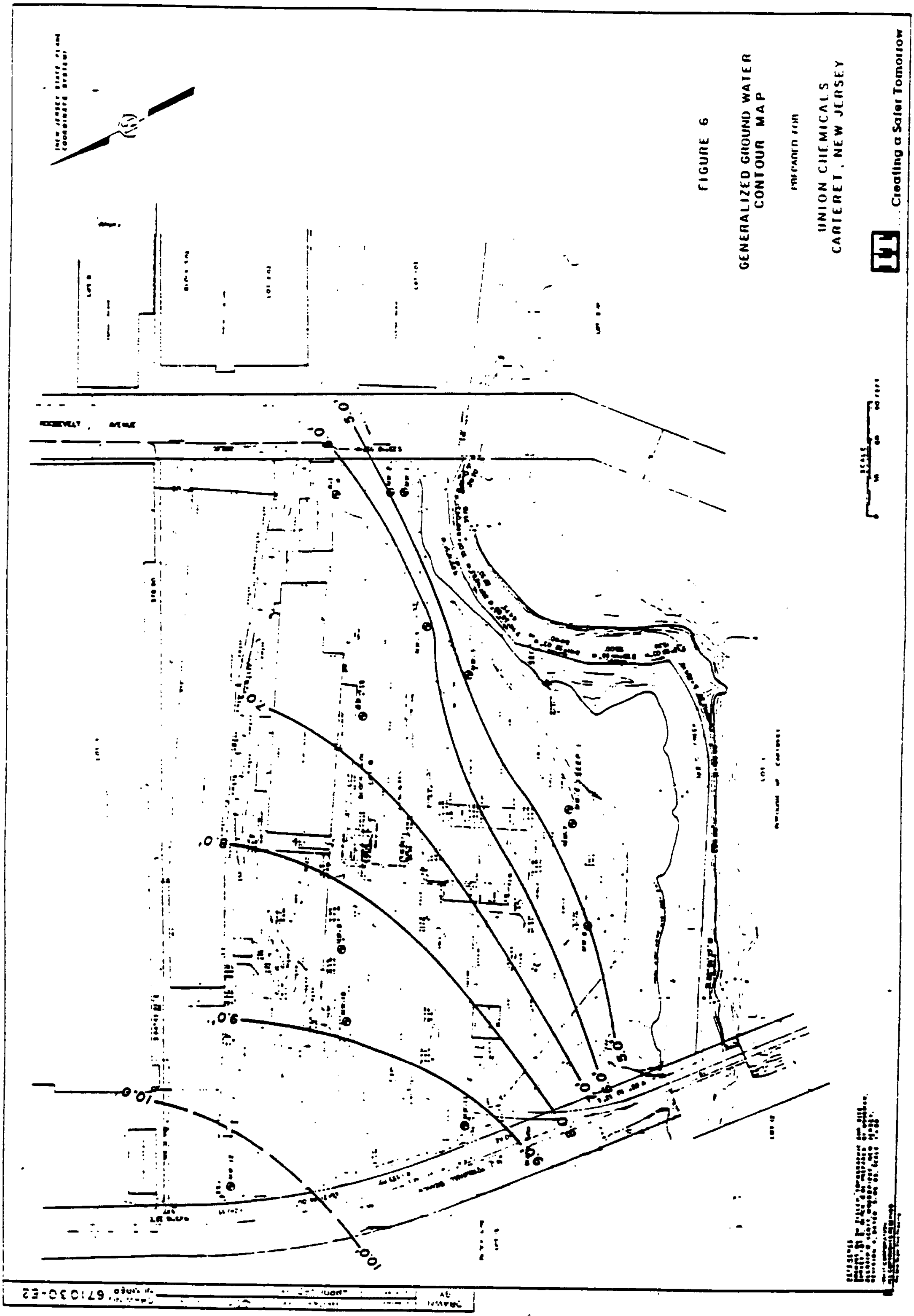


FIGURE 6
GENERALIZED GROUND WATER CONTOUR MAP
PREPARED FOR
UNION CHEMICALS
CARTERET, NEW JERSEY
Creating a Safer Tomorrow
ROOSEVELT AVENUE
5.0
6.0
7.0
8.0
9.0
10.0
671030-E2

Figure A

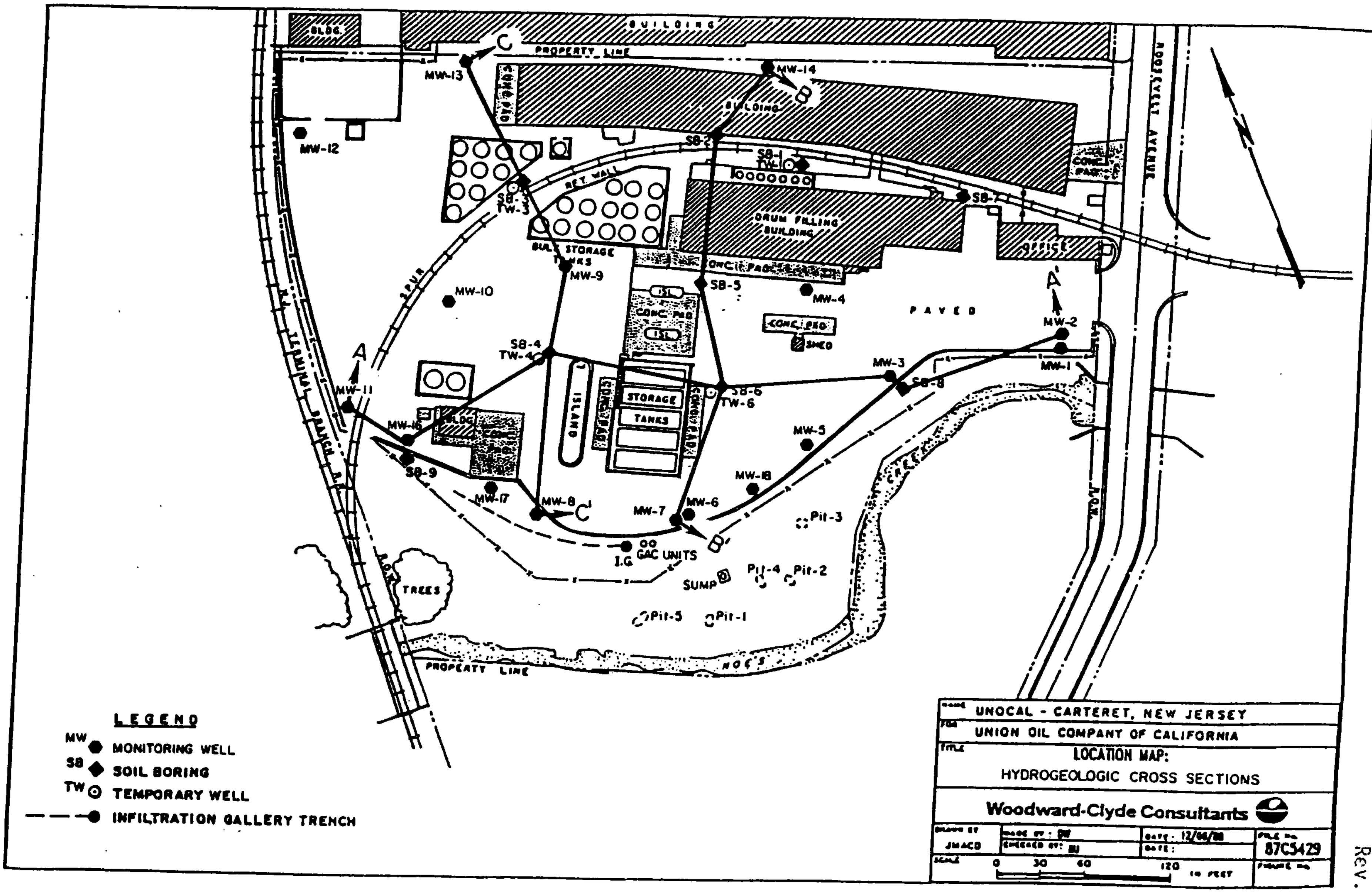


Figure B

02-0804-09-SI
Rev. No. 0

TABLE A - SUMMARY OF GROUNDWATER MONITORING DATA

	Upgradient Wells					Downgradient Wells		
Well No.	MW-10	MW-11	MW-12	MW-13	MW-14	MW-6	MW-7	MW-8
Parameter								
benzene	75			3.8	6.2		1200	9400
chlorobenzene	91	1.4				8000	50	11000
ethyl benzene			24		4.3			
1,1 dichloroethylene							29000	
1,1 dichloroethane				1.2			4800	
1,2 dichloroethane							13000	
toluene	547						4500	
total xylenes					1.0	930		
methylene chloride						1100	48	570
1,1,1 trichloroethane				9.6		3200		
acrolein							500	
chloroethane	8.1							
bromoform			1.0					

Notes:
a All data are in parts per billion.
b Data are from Reference Number 9, Quarterly Sampling Results, January 1989 by Woodward-Clyde Consultants.
c Blank space indicates that parameter was not found above detection limits.

2.1.3 Soil

Nine soil borings were drilled and five tests pits were dug on site. Their locations are shown on Figure A. Available descriptions of samples collected are incomplete, as are sample depths and analytical data. However, the following data were available:

> During excavation of test pits, IT Corporation noted stained soil and free product seeping from the soil at the water table in several pits. Water and soil samples from the test pits showed high concentrations of benzene, toluene, and total xylenes.
>
> Soil samples from soil borings drilled by Woodward-Clyde Consultants are not described adequately and sample depths are unknown; however, high levels of chlorobenzene, methylene chloride, and ethylbenzene were noted in four borings.

There are no critical habitats with one mile of the site. Gateway National Recreation Area is just over one mile east of the site.

Ref. Nos. 2, 3, 11, 14

2.2 WASTE SOURCE DESCRIPTION

The Union Chemical facility has had several spill releases to the environment since 1983. The first spill occurred on February 17, 1983, when approximately 1860 gallons of methyl ethyl ketone (MEK), petroleum naphthalene, and propyl alcohol leaked into Noes Creek and into the subsurface soils. This was the result of an underground pipeline rupture. The pipeline led to an aboveground vertical storage tank (No. 7). The contaminated soil has not been removed as of this writing. Plans for the removal of the contaminated soil are awaiting final approval by the State. The second spill occurred on July 1, 1985, when approximately 500 gallons of xylene leaked into the groundwater. Any contamination of Noes Creek by this spill is unknown. An underground transit line pipe ruptured as it was being fed from the aboveground vertical storage tank (No. 7). Union Chemical was able to recover most of the spill from the groundwater. The third spill occurred in February of 1988, when an aboveground pipe from a vertical storage tank ruptured, releasing 15,000 gallons of 1,1,1-trichloroethane onto the ground. Most of the spill accumulated in a building basement (Drum Filling Building). The 1,1,1-trichloroethane was pumped out of the basement and was recovered. The contaminated soil was removed to a depth of about 3 feet, until a clay layer was reached. A total of 17,360 gallons of waste was spilled. Specific locations of each of these spillls are not known.

Ref. Nos. 1, 2, 13

2.3 GROUNDWATER ROUTE

The Union Chemical Site is located near the contact of the northwestward-sloping bedrock of the Traissic Lowlands and the overlying, southeastward-sloping unconsolidated deposits of the Coastal Plain. The bedrock consists of the Brunswick Formation shale, siltstone, and sandstone, occasionally interrupted by basaltic lava flows and diabase intrusions. The major diabase sill is approximately 1,000 feet thick. It forms the Palisades along the Hudson River, 1.5 miles east of the Union Chemical Site. The Coastal Plain deposits are the Raritan Formation of late Cretaceous Age, consisting of light-colored alternating sands, clays, and gravels, with interbedded marine sediments and peat. These deposits change locally in thickness because they were deposited on the irregular surface of Triassic bedrock. The Brunswick Formation underlies the entire area. Glacial drift of the Wisconsin glacial period was deposited over the bedrock and Coastal Plain material. The site is located in a 100-year floodplain.

On the site, glacial drift has been removed and replaced by fill deposits ranging in thickness up to at least 15 feet. The fill is composed of fine to coarse sands with some gravels, clay, bricks, concrete, metal, glass, and slag. These materials have low to moderate hydraulic conductivities, ranging from 10^{-3} to 10^{-5} cm/sec. Groundwater flows from north to south across the site. Depth to groundwater varies from 5 feet from ground surface at the southeast edge of the property near Noes Creek, to 10 feet at the northeast edge of the property.

The aquifer of concern includes the unconsolidated material of the Raritan Formation, extending downward to the top of the Raritan Fire Clay, a member of the Raritan Formation. The Raritan Fire Clay acts as a confining unit, hydraulically separating the rest of the Raritan Formation from the underlying Brunswick Formation Aquifer. There is another clay layer within the Raritan Formation; however, there appears to have been vertical leakage of contaminants through this clay layer. This was suggested by the increase in contaminant levels in deeper wells downgradient of waste sources. Additional sampling and later reports by IT Corporation suggested that the leakage may not be as great as first thought. Permeability of this clay is about 10^{-8} cm/sec. For the purposes of this report the aquifer of concern will remain as extending from the water table to the top of the Raritan Fire Clay.

Several sampling events have shown that there is, and continues to be, observed release of contaminants to groundwater. IT Corporation noted free product in three downgradient monitoring wells following a 1985 emergency response to seepage of product into Noes Creek. Free product was also observed flowing into test pits at the water table. Most recently, quarterly sampling of monitoring wells conducted in January 1989 by Unocal Chemicals (see Section 2.1.1) shows significantly higher concentrations of volatile organic compounds in wells downgradient of the site. These compounds include benzene, chlorobenzene, 1,1-dichloroethylene, 1,1-dichloroethane, 1,2-dichloroethane, and toluene.

No part of the population utilizes groundwater within the 3-mile radius of the site. The Middlesex Water Company supplies potable water to the entire area from the Raritan River. There are no private wells in the area. The 3-mile radius of the site includes portions of the cities of Rahway and Linden, the borough of Carteret, the township of Woodbridge, and parts of Staten Island.

The annual net precipitation is 11 inches in the area. Only one industrial well is known to exist within the 3-mile radius of the site. This well taps the Brunswick Formation and is located less than one-quarter mile from the site.

Ref. Nos. 1, 2, 3, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18

2.4 SURFACE WATER ROUTE

There is no observed release documented. Noes Creek is a tributary of Arthur Kill that parallels the site to the south. The site is less than 1000 feet west of the Arthur Kill. The area slopes approximately 3 to 5 percent in a southerly direction toward the creek. Noes Creek empties into the Arthur Kill, which eventually empties into the Raritan Bay. No critical habitats of federally endangered species exist within 1 mile. The 1-year 24 hour rainfall is between 2.5 and 3 inches.

There is no known use of these surface waters for drinking. Arthur Kill is not approved for swimming purposes. Though fishing is permitted, Health Department officials say that fishermen eat the fish at their own risk. No other recreational activities are reported for the Arthur Kill. Raritan Bay and many of Arthur Kill's tributaries have similar restrictions. The Island of the Meadows is 2,000 feet southeast of the site. There are tidal flats within 0.25 mile of the site. Noes Creek is a tidally influenced creek that is adjacent to the site. Two surface water samples were collected on June 6, 1986 from Noes Creek. Both samples were collected simultaneously during ebb tide. The locations of the samples, SW-1 and SW-2, were chosen to represent conditions just upstream (west) and just downstream (east), respectively, of the site. The locations were chosen such that during ebb tide it was expected that the quality of the water flowing to location SW-1 would not be influenced by the site and, conversely, the quality of water flowing to the location SW-2 would be influenced by the site. Since it is not documented that such effects as eddy currents and re-entrainment of contaminated sediment can be discounted, these data cannot be used to document an observed release. Based on reports of spills and seeps into Noes Creek, however, further study may be able to document a release.

Ref. Nos. 10, 11, 12, 19, 20

2.5 AIR ROUTE

No readings above background were detected in the ambient air on the OVA or HNu during the on-site reconnaissance conducted on March 7, 1989.

There are no historic landmarks within view of the site.

Ref. Nos. 2, 21

2.6 ACTUAL HAZARDOUS CONDITIONS

There is evidence of an observed release which contaminated groundwater at the facility. The groundwater on site contained high concentrations of volatile organic compounds. There is a strong potential for contamination of surface and subsurface soil and Noes Creek.

No other actual hazardous conditions pertaining to human or environmental contamination have been documented. Specifically:

- Contamination has not been documented either in organisms in a food chain leading to humans or in organisms directly consumed by humans.
- There have been no documented observed incidents of direct physical contact with hazardous substances at the facility involving a human being (not including occupational exposure) or a domestic animal.
- There have been no documented incidents of damage to flora (e.g., stressed vegetation) or to fauna (e.g., fish kill) that can be attributed to the hazardous material at the facility.
- There is no documented contamination of a sewer or storm drain.

Ref. Nos. 2, 9, 14

3.0 MAPS AND PHOTOS

UNION CHEMICAL
CARTERET, NEW JERSEY

CONTENTS

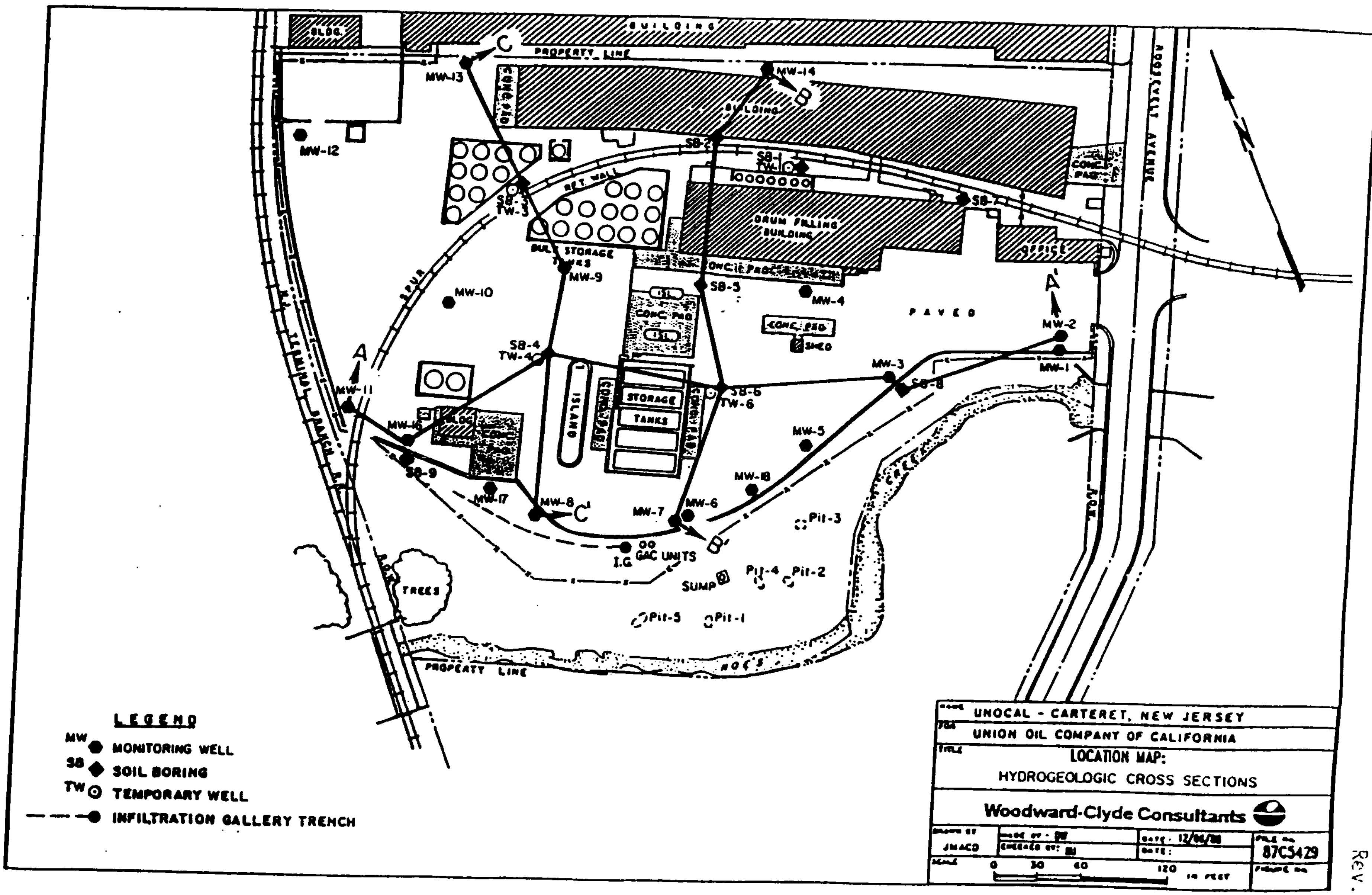
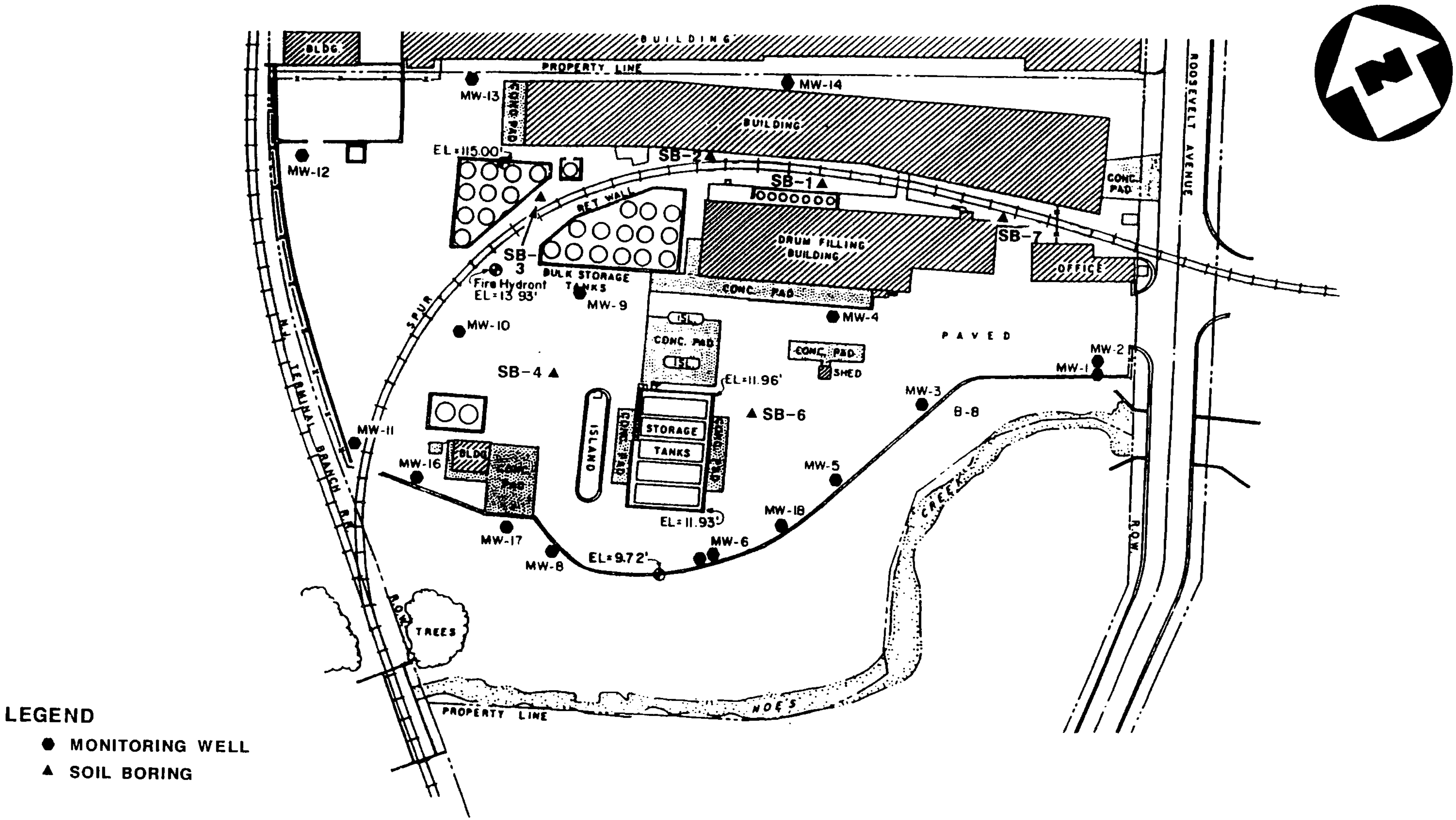


Figure 1

02-8804-09-SI
Rev. No. 0



SITE MAP

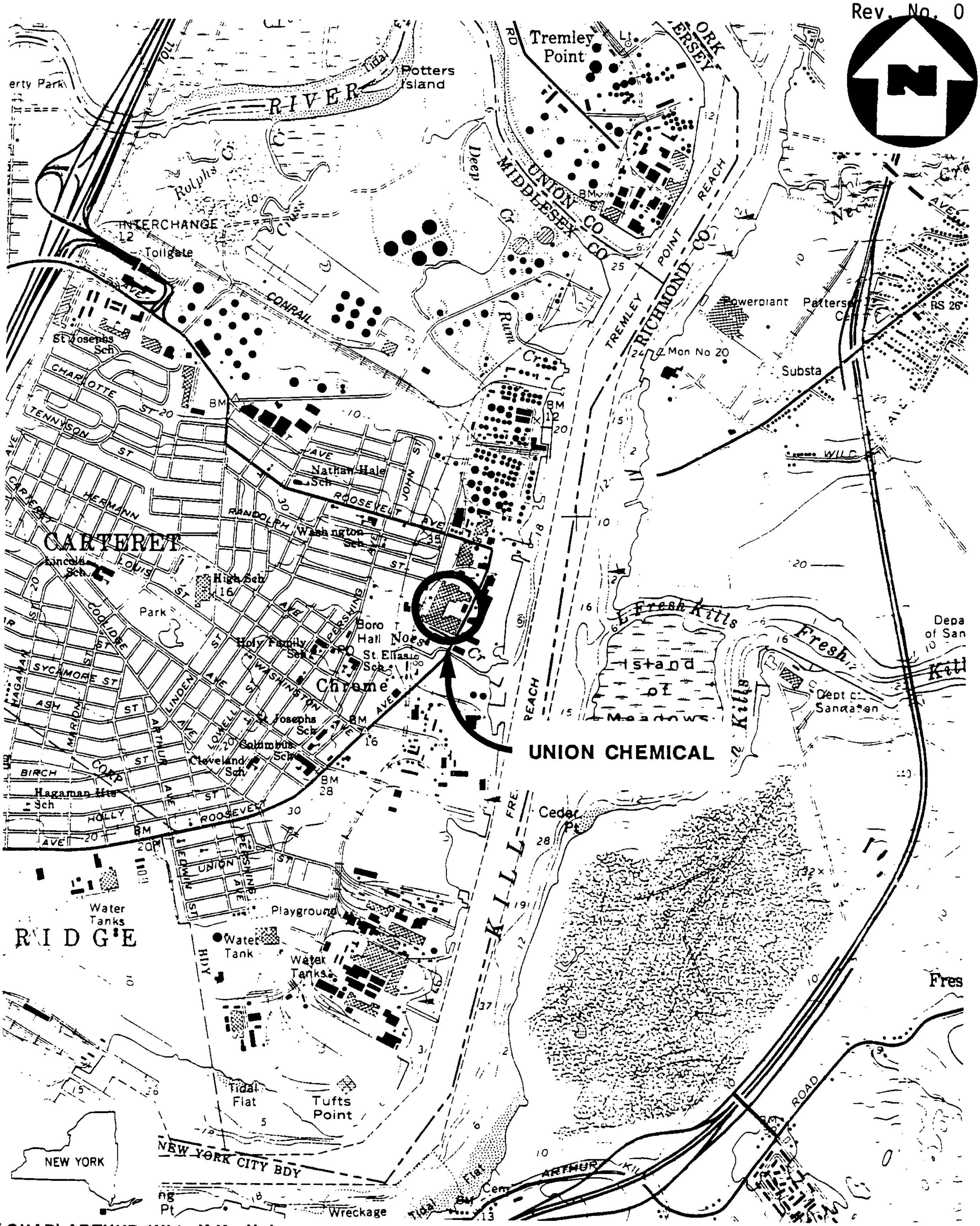
UNION CHEMICAL, CARTERET, N.J.

NOT TO SCALE

FIGURE 2

NUS CORPORATION

02-8804-09-SI
Rev. No. 0



(QUAD) ARTHUR KILL, N.Y.-N.J.

SITE LOCATION MAP
UNION CHEMICAL, CARTERET, N.J.

SCALE: 1" = 2000'

FIGURE 2a

NUS CORPORATION

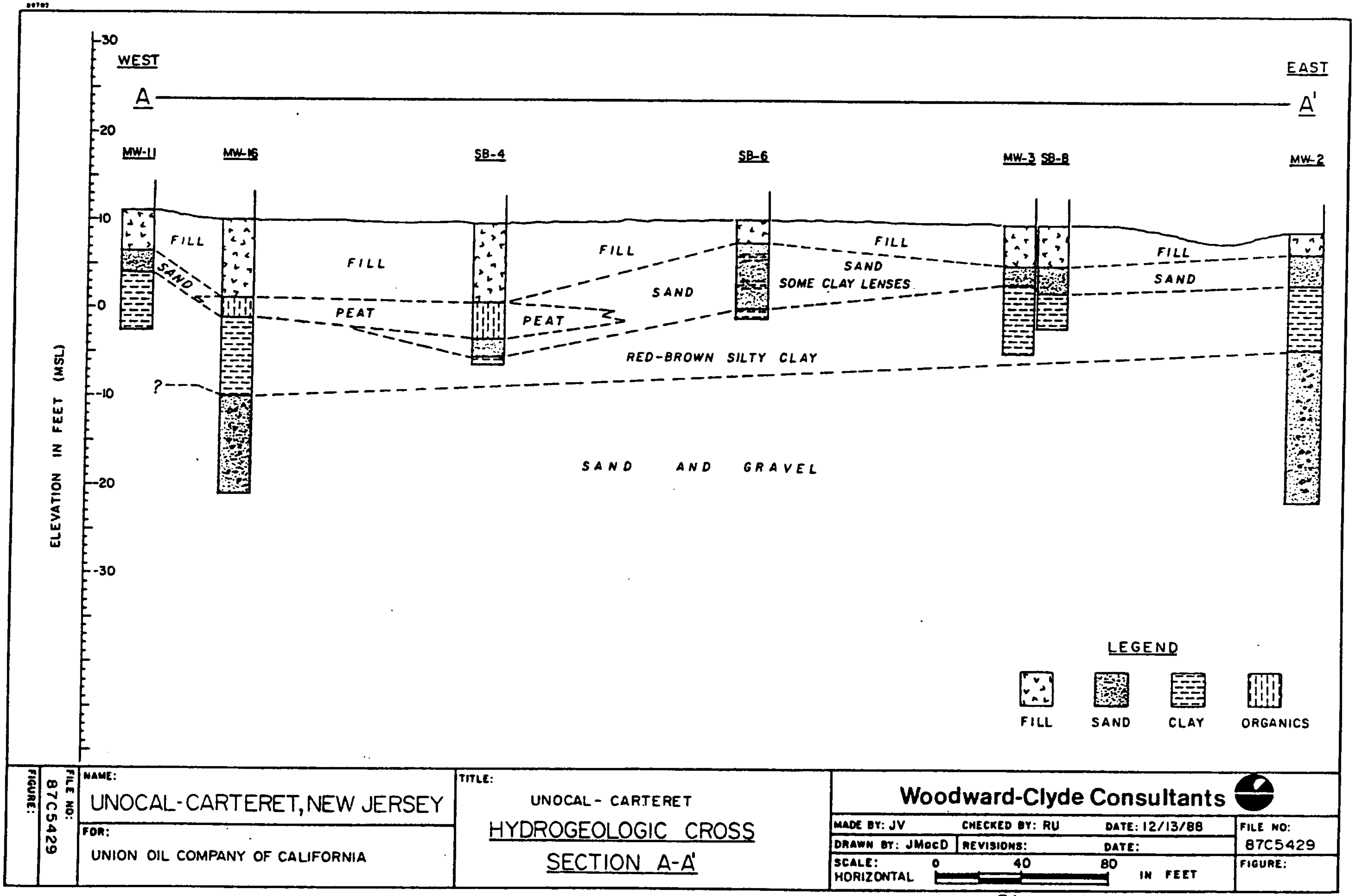

WEST
EAST
A
A'
MW-11
MW-16
SB-4
SB-6
MW-3
SB-8
MW-2
FILL
SAND
PEAT
SOME CLAY LENSES
RED-BROWN SILTY CLAY
SAND AND GRAVEL
ELEVATION IN FEET (MSL)
30
20
10
0
-10
-20
-30
LEGEND
FILL
SAND
CLAY
ORGANICS
NAME:
UNOCAL-CARTERET, NEW JERSEY
FOR:
UNION OIL COMPANY OF CALIFORNIA
TITLE:
UNOCAL - CARTERET
HYDROGEOLOGIC CROSS SECTION A-A'
Woodward-Clyde Consultants
MADE BY: JV
CHECKED BY: RU
DATE: 12/13/88
DRAWN BY: JMacD
REVISIONS:
DATE:
SCALE: HORIZONTAL 0 40 80 IN FEET
FILE NO: 87C5429
FIGURE:

Figure 3

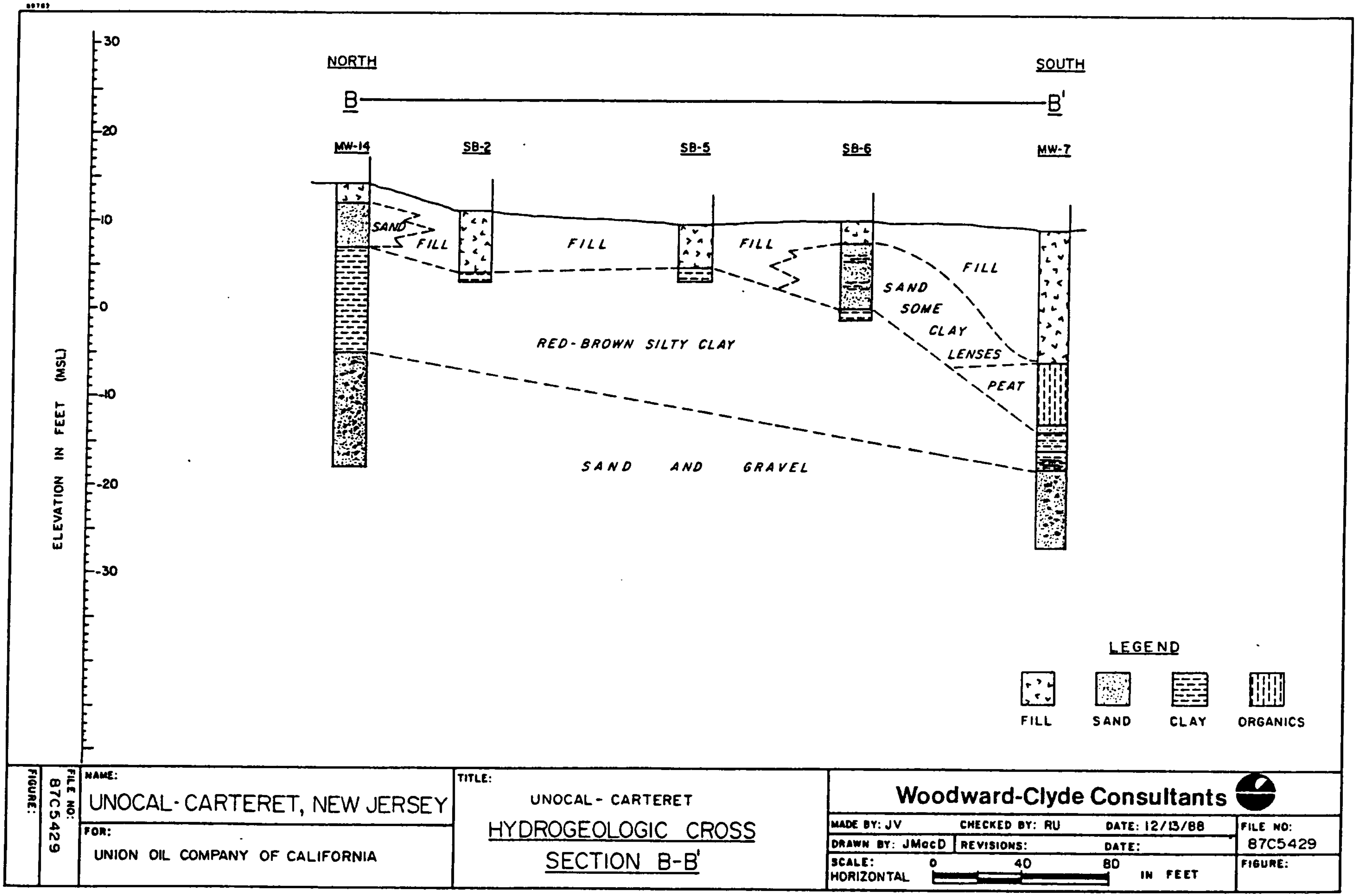

NORTH
SOUTH
B
B'
MW-14
SB-2
SB-5
SB-6
MW-7
30
20
10
0
-10
-20
-30
ELEVATION IN FEET (MSL)
SAND
FILL
FILL
FILL
FILL
SAND
SOME
CLAY
LENSES
PEAT
RED-BROWN SILTY CLAY
SAND AND GRAVEL
LEGEND
FILL
SAND
CLAY
ORGANICS
FIGURE:
FILE NO: 87C5429
NAME:
UNOCAL-CARTERET, NEW JERSEY
FOR:
UNION OIL COMPANY OF CALIFORNIA
TITLE:
UNOCAL - CARTERET
HYDROGEOLOGIC CROSS SECTION B-B'
Woodward-Clyde Consultants
MADE BY: JV
CHECKED BY: RU
DATE: 12/13/88
DRAWN BY: JMacD
REVISIONS:
DATE:
FILE NO: 87C5429
SCALE: HORIZONTAL
0
40
80
IN FEET
FIGURE:

Figure 4

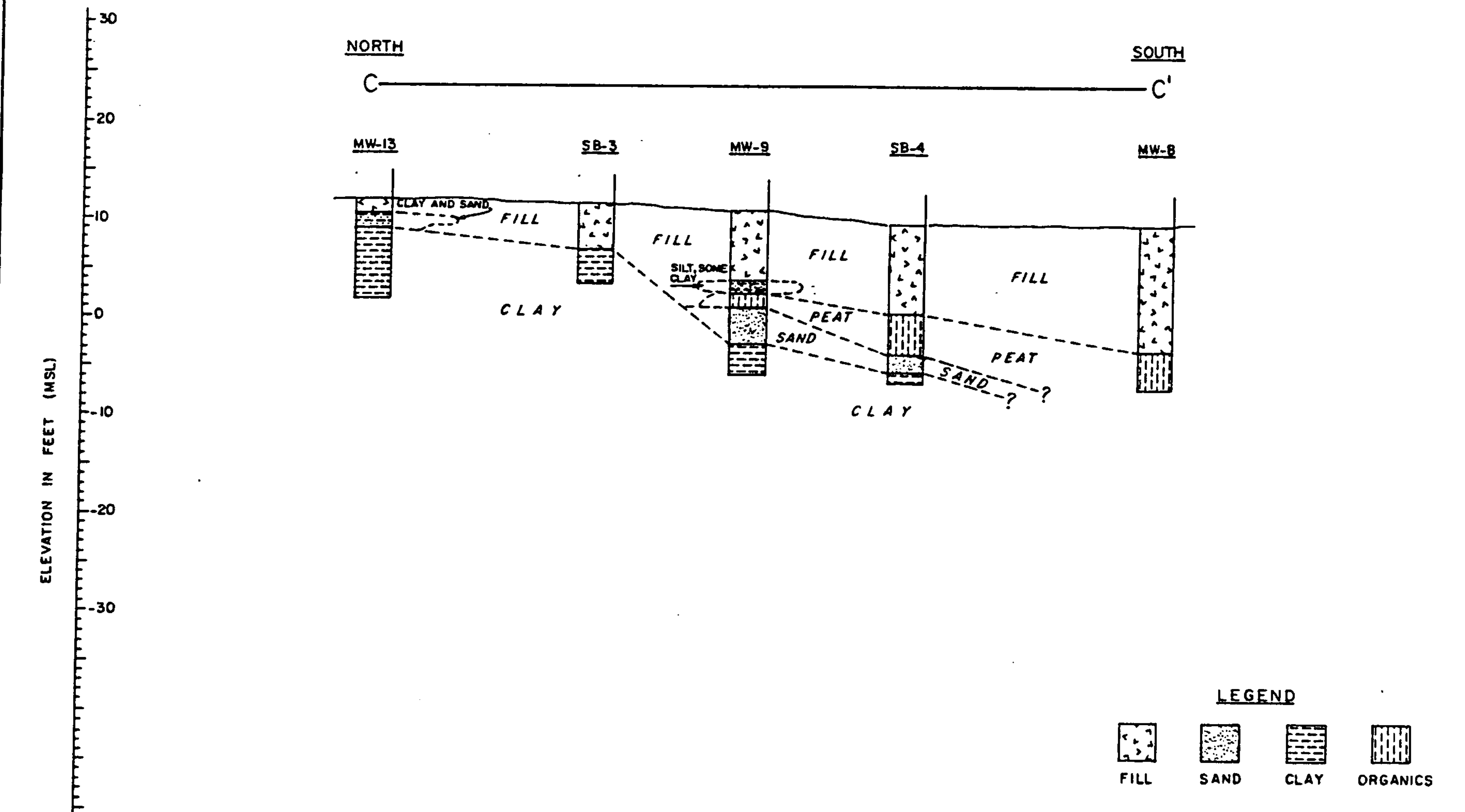


FIGURE:	FILE NO: 87C5429	NAME: UNOCAL-CARTERET, NEW JERSEY
		FOR: UNION OIL COMPANY OF CALIFORNIA

TITLE:
UNOCAL- CARTERET
HYDROGEOLOGIC CROSS SECTION C-C'

Woodward-Clyde Consultants

MADE BY: JV	CHECKED BY: RU	DATE: 12/13/88	FILE NO: 87C5429
DRAWN BY: JMacD	REVISIONS:	DATE:	
SCALE: HORIZONTAL 0 40 80 IN FEET			FIGURE:

Figure 5

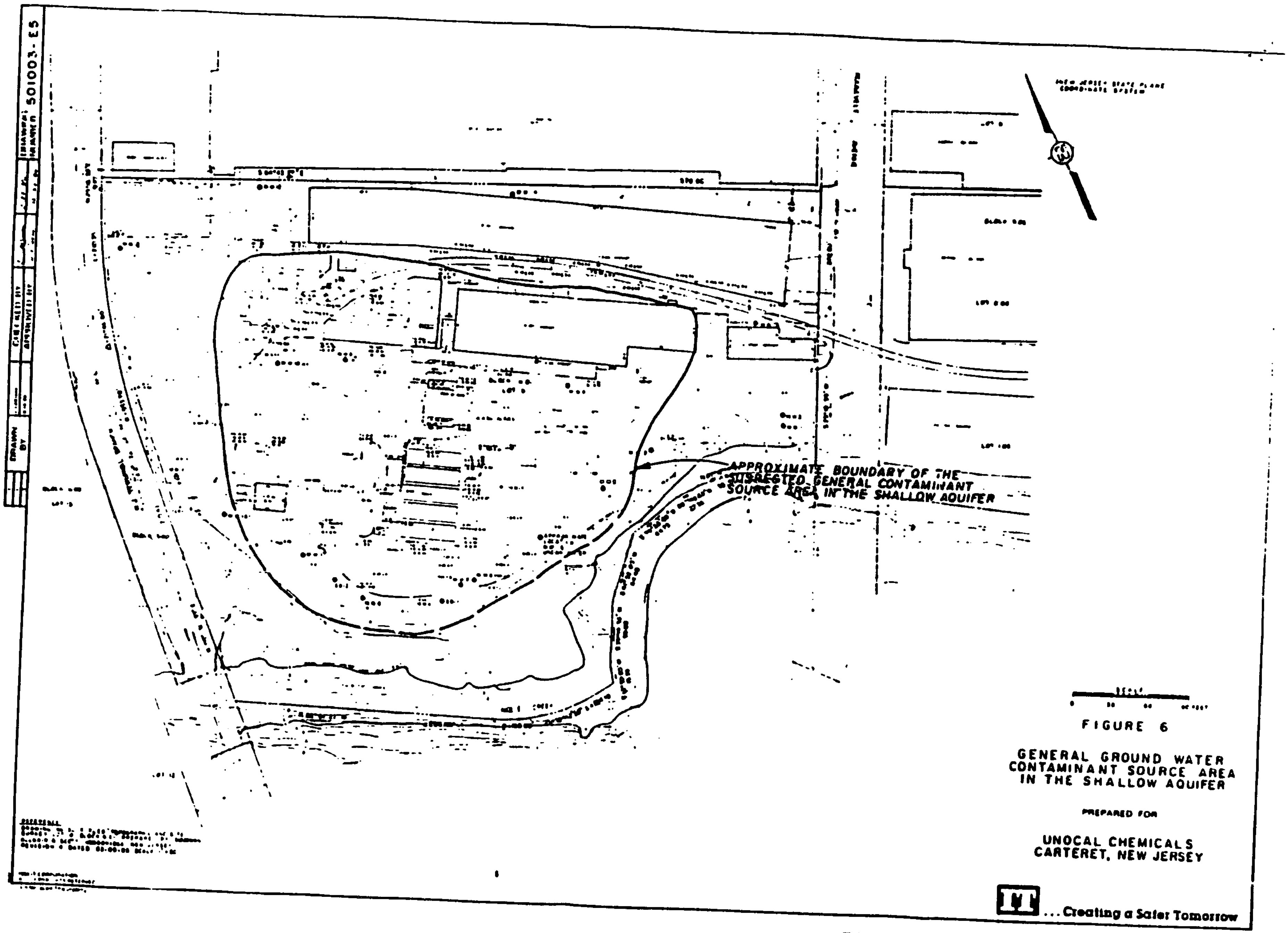

501003-E5
APPROXIMATE BOUNDARY OF THE SUSPECTED GENERAL CONTAMINANT SOURCE AREA IN THE SHALLOW AQUIFER
FIGURE 6
GENERAL GROUND WATER CONTAMINANT SOURCE AREA IN THE SHALLOW AQUIFER
PREPARED FOR
UNOCAL CHEMICALS
CARTERET, NEW JERSEY
... Creating a Safer Tomorrow

Figure 6

EXHIBIT A

PHOTOGRAPH LOG

UNION CHEMICAL
CARTERET, NEW JERSEY

ON-SITE RECONNAISSANCE: MARCH 8, 1989

UNION CHEMICAL
CARTERET, NEW JERSEY

MARCH 8, 1989

PHOTOGRAPH INDEX

ALL PHOTOGRAPHS TAKEN BY GLENN A. CALABRESE.

Photo Number	Description	Time
1P-1	Well No. 1.	1045
1P-2	Noes Creek looking east.	1058
1P-3	Noes Creek looking west.	1059
1P-4	The background area of disturbed soil was the location of the underground pipeline rupture causing the spills of 1983 and 1985.	1127
1P-5	Spill area of 1,1,1 - trichloroethane.	1120
1P-6	Vertical tank(No. 223)storage of 1,1,1, - trichloroethane.	1125

UNION CHEMICAL
CARTERET, NEW JERSEY

1P-1 March 7, 1989 1045
Well No. 1.

1P-2 March 7, 1989 1058
Noes Creek looking east.

UNION CHEMICAL

1P-3 March 7, 1989 1059
Noes Creek looking west.

1P-4 March 7, 1989 1127
The background area of disturbed soil was the location of the underground pipeline rupture causing the spills of 1983 and 1985.

UNION CHEMICAL
CARTERET, NEW JERSEY

1P-5 March 7, 1989 1120
Spill area of 1,1,1 - trichloroethane.

1P-6 March 7, 1989 1125
Vertical tank (No.223) storage of 1,1,1, - trichloroethane.

4.0 SITE INSPECTION SAMPLING RESULTS

NUS Corporation Region 2 FIT did not sample the site, as there are sufficient data to make a recommendation for **NO FURTHER REMEDIAL ACTION PLANNED (NFRAP)**. Data are discussed in Section 2.1.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The groundwater of the Union Chemical Site has been contaminated with volatile organic compounds. Though contamination exists in the groundwater and surface water, no part of the population within a 3-mile radius utilizes groundwater, nor is there a surface water intake downstream. The Union Chemical owners have submitted a plan to the State for removal of contaminated soil. The plan is awaiting final approval by the State.

It is recommended that the monitoring wells continue to be sampled quarterly.

A recommendation of **NO FURTHER REMEDIAL ACTION PLANNED (NFRAP)** is given for this site, based on the lack of groundwater and surface water use. There is no significant potential for migration via the air route. There is some potential for direct contact with contaminated soils, although a large amount of soil has already been removed.

6.0 REFERENCES

1. Preliminary Assessment prepared by Frank Faranca, NJDEP, OHWM/BPA, May 22, 1987.

2. Field Notebook No. 0402, Union Chemical, TDD No. 02-8804-09, NUS Region 2 FIT, Edison, New Jersey, March 7, 1989.

3. Analytical results of soil borings for Union Chemical, Nanco Laboratories for Woodward-Clyde Consultants, September 1988.

4. Telecon Note: Conversation between Mr. Wolansky, Union Chemical, and Glenn A. Calabrese, NUS Corp., March 9, 1989.

5. Telecon Note: Conversation between Mr. D. Dierwerchter, Union Chemical, and Glenn A. Calabrese, NUS Corp., March 10, 1989.

6. Telecon Note: Conversation between Mr. Wolansky, Union Chemical, and Glenn A. Calabrese, NUS Corp., March 10, 1989.

7. Telecon Note: Conversation between Mr. D. Dierwechter, Union Chemical, and Glenn A. Calabrese, NUS Corp., March 16, 1989.

8. Flood Insurance Rate Map, Carteret, Middlesex County, NJ Community-Panel Number 340257 0005 A, November 15, 1978.

9. Quarterly Sampling Results, Unocal Chemicals, NJPDES #0026077, Groundwater Analyses, Woodward-Clyde Consultants, January 1989.

10. Three-mile radius map based on the U.S. Department of the Interior, Geological Survey Topographic Map, 7.5 minute series, "Arthur Kill Quadrangle, N.J." 1955.

11. Final Report for Union Chemical, Project 671030, IT Corporation, Nov. 25, 1985.

12. Uncontrolled hazardous waste site ranking system, A user's manual, 40 CFR, Part 300, Appendix A, 1986.

13. Telecon Note: Conversation between Mr. Sergio Leone, Union Chemical, and Glenn A. Calabrese, NUS Corp., April 14, 1989.

14. Final Report, Additional Site Assessment for Union Chemical, including Data Analyses. Project No. 303331, IT Corporation, December 1986.

15. Geology and Ground-Water Resources of Union County, New Jersey, U.S. Geological Survey Water Resources Investigations 76-73, June 1976.

16. Policies and Practices for Managing Middlesex County's Groundwater Resources, Middlesex County Planning Board, New Brunswick, September 1974.

17. Soil Survey Middlesex County, New Jersey, United States Dept. of Agriculture.

18. State of New Jersey Department of Conservation and Economic Development, Division of Water Policy and Supply, Special Report No. 27, Henry R. Anderson, U.S. Geological Survey, 1968.

6.0 REFERENCES(Cont'd)

19. Fish and Wildlife Service List of Endangered and Threatened Wildlife and Plants, the Bureau of National Affairs, Inc. Washington, D.C. 20037.

20. Telecon Note: Conversation between Mr. Dellamo, Woodbridge Health Dept., and Glenn A. Calabrese, NUS Corp. February 16, 1989.

21. New Jersey and National Registers of Historic Places, NJDEP, Division of Parks and Forestry, 1984.

22. U.S. Fish and Wildlife Service, 1980. Atlantic Coast Ecological Inventory, Newark N.J.-N.Y.-PA. Sheet.

REFERENCE NO. 1

Preliminary Assessment

Union Chemicals - Div. of Union Oil Co.
350 Roosevelt Avenue
Carteret Borough/Middlesex County
New Jersey

EPA # NJD063173280

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT
PART 1 - SITE INFORMATION AND ASSESSMENT

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
NJ	D063173280

II. SITE NAME AND LOCATION

01 SITE NAME (Legal, common, or descriptive name of site): Union Chemicals - Div. of Union Oil Co.	02 STREET, ROUTE NO., OR SPECIFIC LOCATION IDENTIFIER: 350 Roosevelt Avenue
03 CITY: Carteret Borough	04 STATE: NJ; 05 ZIP CODE: 07008; 06 COUNTY: Middlesex; 07 COUNTY CODE: 12; 08 CONG DIST:
09 COORDINATES LATITUDE: 40° 34' 42" ; LONGITUDE: 74° 12' 53"	Block: 6.01 Lot: 8 Acreage: 4.436

10 DIRECTIONS TO SITE (Starting from nearest public road)

From Trenton, take the New Jersey Turnpike North to Exit 12. Take Roosevelt Avenue East pass FMC Corporation and site is on the right before Noes Creek.

III. RESPONSIBLE PARTIES

01 OWNER (if known): American Mineral Spirits Col	02 STREET (Business, mailing, residential): 1900 E. Golf Road
03 CITY: Schaumburg	04 STATE: IL; 05 ZIP CODE: 60195; 06 TELEPHONE NUMBER: (312) 490-2500; H. J. Kopp
07 OPERATOR (If known and different from owner):	08 STREET (Business, mailing, residential):
09 CITY:	10 STATE: ; 11 ZIP CODE: ; 12 TELEPHONE NUMBER: ( )

13 TYPE OF OWNERSHIP (Check one)

☒ A. PRIVATE ☐ B. FEDERAL: ______ (Agency name) ☐ C. STATE ☐ D. COUNTY ☐ E. MUNICIPAL
☐ F. OTHER: ______ (Specify) ☐ G. UNKNOWN

14 OWNER/OPERATOR NOTIFICATION ON FILE (Check all that apply)

☐ A. RCRA 3001 DATE RECEIVED: __/__/__ (MONTH DAY YEAR) ☒ B. UNCONTROLLED WASTE SITE (CERCLA 103 c) DATE RECEIVED: __/__/__ (MONTH DAY YEAR) ☐ C. NONE

IV. CHARACTERIZATION OF POTENTIAL HAZARD

01 ON SITE INSPECTION: ☒ YES ☐ NO DATE: 2 / 17 / 83 (MONTH DAY YEAR)

BY (Check all that apply): ☐ A. EPA ☐ B. EPA CONTRACTOR ☒ C. STATE ☒ D. OTHER CONTRACTOR ☐ E. LOCAL HEALTH OFFICIAL ☐ F. OTHER: USCG (Specify)

CONTRACTOR NAME(S): Moran Crowley

02 SITE STATUS (Check one): ☒ A. ACTIVE ☐ B. INACTIVE ☐ C. UNKNOWN

03 YEARS OF OPERATION: 1963 (BEGINNING YEAR) | Present (ENDING YEAR) ☐ UNKNOWN

04 DESCRIPTION OF SUBSTANCES POSSIBLY PRESENT, KNOWN, OR ALLEGED

Various volatile and semivolatile organic compounds including xylene, toluene, benzene and petroluem napthalene.

05 DESCRIPTION OF POTENTIAL HAZARD TO ENVIRONMENT AND/OR POPULATION

A low potential exists for human exposure, however, a high possibility of impact on the environmental biota in Noes Creek and the Arthur Kill are present.

V. PRIORITY ASSESSMENT

01 PRIORITY FOR INSPECTION (Check one. If high or medium is checked, complete Part 2 - Waste Information and Part 3 - Description of Hazardous Conditions and Incidents)

☐ A. HIGH (Inspection required promptly) ☒ B. MEDIUM (Inspection required) ☐ C. LOW (Inspect on time available basis) ☐ D. NONE (No further action needed, complete current disposition form)

VI. INFORMATION AVAILABLE FROM

01 CONTACT	02 OF (Agency/Organization)		03 TELEPHONE NUMBER
Nigel Robinson	USEPA - Region II		(212) 264-0854

04 PERSON RESPONSIBLE FOR ASSESSMENT	05 AGENCY	06 ORGANIZATION	07 TELEPHONE NUMBER	08 DATE
Frank Faranca, HSMS IV	NJDEP	DHWM/BPA	(609 633-2219	5 / 22 / 87 (MONTH DAY YEAR)

EPA FORM 2070-12 (7-81)

EPA

POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 2 - WASTE INFORMATION

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER
NJ	D063173280

II. WASTE STATES, QUANTITIES, AND CHARACTERISTICS

01 PHYSICAL STATES (Check all that apply)

- [ ] A. SOLID
- [ ] B. POWDER, FINES
- [ ] C. SLUDGE
- [ ] D. OTHER ______ (Specify)
- [ ] E. SLURRY
- [x] F. LIQUID
- [ ] G. GAS

02 WASTE QUANTITY AT SITE (Measures of waste quantities must be independent)

TONS ______

CUBIC YARDS ______

NO. OF DRUMS 47.2

03 WASTE CHARACTERISTICS (Check all that apply)

- [x] A. TOXIC
- [ ] B. CORROSIVE
- [ ] C. RADIOACTIVE
- [ ] D. PERSISTENT
- [ ] E. SOLUBLE
- [ ] F. INFECTIOUS
- [x] G. FLAMMABLE
- [x] H. IGNITABLE
- [x] I. HIGHLY VOLATILE
- [ ] J. EXPLOSIVE
- [ ] K. REACTIVE
- [ ] L. INCOMPATIBLE
- [ ] M. NOT APPLICABLE

III. WASTE TYPE

CATEGORY	SUBSTANCE NAME	01 GROSS AMOUNT	02 UNIT OF MEASURE	03 COMMENTS
SLU	SLUDGE			Several releases have occurred
OLW	OILY WASTE			in the past four (4) years
SOL	SOLVENTS	2360	Gallons	causing contamination of the
PSD	PESTICIDES			soil, groundwater, surface
OCC	OTHER ORGANIC CHEMICALS			water and air.
IOC	INORGANIC CHEMICALS			
ACD	ACIDS			
BAS	BASES			
MES	HEAVY METALS			

IV. HAZARDOUS SUBSTANCES (See Appendix for most frequently cited CAS Numbers)

01 CATEGORY	02 SUBSTANCE NAME	03 CAS NUMBER	04 STORAGE/DISPOSAL METHOD	05 CONCENTRATION	06 MEASURE OF CONCENTRATION
SOL	Xylene	95-47-6	Groundwater sample	64,000,000	PPB
SOL	Benzene	71-43-2	Groundwater sample	1,000,000	PPB
SOL	Vinyl Chloride	75-01-4	Groundwater sample	60	PPB
SOL	Tetrachloroethylene	127-18-4	Soil Sample	2,100	PPB
SOL	Ethylbenzene	100-41-4	Groundwater sample	2,700	PPB
SOL	Toluene	108-88-3	Groundwater sample	3,600,000	PPB
SOL	1,1,1-Trichloroethane	71-55-6	Soil sample	510	PPB
SOL	Chloroethane	75-00-3	Groundwater sample	1,600	PPB
SOL	1,1,2,2-Tetrachloroethane	79-34-5	Groundwater sample	15	PPB
SOL	Methylethyl Ketone	78-93-3	Groundwater sample	100	PPB
SOL	Chlorobenzene	108-90-7	Groundwater sample	230,000	PPB
SOL	Methylbromide	74-83-9	Surface water sample	1,400	PPB
SOL	4-methyl-2-pentanone	108-10-1	Surface water sample	2,700	PPB
SOL	Styrene	100-42-5	Surface water sample	690	PPB
SOL	Trichloroethylene	79-01-6	Groundwater sample	11	PPB
SOL	Methylene Chloride	75-09-2	Groundwater sample	630	PPB

V. FEEDSTOCKS (See Appendix for CAS Numbers)

CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER	CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER
FDS			FDS		
FDS			FDS		
FDS			FDS		
FDS			FDS		

VI. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

See reference sheet for a list of attachments

EPA POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS	I. IDENTIFICATION 01 STATE: NJ 02 SITE NUMBER: D063173280

II. HAZARDOUS CONDITIONS AND INCIDENTS

01 X A. GROUNDWATER CONTAMINATION — 02 X OBSERVED (DATE: 10/10/85) — ☐ POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ — 04 NARRATIVE DESCRIPTION

The groundwater was sampled and analyzed by IT Corporation on 10/10/85. Test results revealed elevated levels of various volatile organic compounds including xylene as high as 64,000,000 PPB. Both a horizontal and vertical migration of the contaminants were observed.
Attachment C

01 X B. SURFACE WATER CONTAMINATION — 02 X OBSERVED (DATE: 6/25/85) — ☐ POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ — 04 NARRATIVE DESCRIPTION

Groundwater discharges and surface water seeps flowing into Noes Creek were sampled and analyzed. High levels of various volatile organic compounds were detected. A large oil sheen was also observed on Noes Creek by plant personnel.
Attachment C

01 X C. CONTAMINATION OF AIR — 02 X OBSERVED (DATE: 2/17/83) — ☐ POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ — 04 NARRATIVE DESCRIPTION

NJDEP inspectors investigated the facility during the 2/17/83 spill incident in which the soil was observed to be darkly stained and a chemical odor was present. High OVA readings WERE ALSO OBSERVED.
Attachment A

01 X D. FIRE/EXPLOSIVE CONDITIONS — 02 ☐ OBSERVED (DATE: ______) — X POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ — 04 NARRATIVE DESCRIPTION

A potential for fire/explosive conditions exists due to the large amount of product loss of highly volatile compounds. However, in the two (2) years since the last major spill many of the contaminants may have volatilized.
Attachment A, B

01 X [illegible] — 02 [illegible] — X POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ — 04 NARRATIVE DESCRIPTION

The entire facility is fenced to prevent unauthorized access to the facility by the general population. A potential does exist for direct contact by Union Chemical personnel.
Attachment C, D

01 X F. CONTAMINATION OF SOIL — 02 X OBSERVED (DATE: 2-17-83) — ☐ POTENTIAL — ☐ ALLEGED
03 AREA POTENTIALLY AFFECTED: ______ (Acres) — 04 NARRATIVE DESCRIPTION

Three separate spill incidents were observed from 1983 to 1986 in which various volatile organic compounds were released into the soil beneath the facility consequently contaminating the groundwater.
Attachment A, B

01 ☐ G. DRINKING WATER CONTAMINATION — 02 ☐ OBSERVED (DATE: ______) — ☐ POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ — 04 NARRATIVE DESCRIPTION

The Middlesex Water Company supplies potable water to the entire area surrounding the facility. There are no known private wells located in the area.
Attachment C, D

01 X H. WORKER EXPOSURE/INJURY — 02 ☐ OBSERVED (DATE: ______) — X POTENTIAL — ☐ ALLEGED
03 WORKERS POTENTIALLY AFFECTED: ______ — 04 NARRATIVE DESCRIPTION

A potential exists for worker exposure/injury of Union Chemical personnel who come into direct contact with the contaminated soil and ground water seeps that are on site.
Attachment C

01 X I. POPULATION EXPOSURE/INJURY — 02 ☐ OBSERVED (DATE: ______) — X POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ — 04 NARRATIVE DESCRIPTION

A potential exists for population exposure indirectly by ingestion of contaminated fish caught in the Arthur Kill and by dermal and inhalation routes during the recreational use of surface waters.
Attachment C

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION
01 STATE: NJ | 02 SITE NUMBER: D063173280

II. HAZARDOUS CONDITIONS AND INCIDENTS (Continued)

01 [X] J. DAMAGE TO FLORA — 02 ☐ OBSERVED (DATE: ______) [X] POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

A potential exists for damage to Phragmites communis species found on either side of Noes Creek and the banks of the Arthur Kill.

01 [X] K. DAMAGE TO FAUNA — 02 ☐ OBSERVED (DATE: ______) [X] POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION (include name(s) of species)

The volatile organics in the groundwater will be attenuated due to evaporation at the surface water/air interface, however, the introduction of semivolatile pollutants could accumulate in bottom sediment with adverse effects on aquatic biota. Att. C

01 [X] L. CONTAMINATION OF FOOD CHAIN — 02 ☐ OBSERVED (DATE ______) [X] POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

The migration of semivolatile organic pollutants (i.e., PAH's - Napthalene) in the nonaqueous fraction of contaminated groundwater could adsorb to colloidal particles in surface water and bio-magnify into a significant environmental exposure. Att. C

01 [X] M. UNSTABLE CONTAINMENT OF WASTES — 02 ☐ OBSERVED (DATE ______) [X] POTENTIAL ☐ ALLEGED
(Spills/runoff/standing liquids/leaking drums)
03 POPULATION POTENTIALLY AFFECTED: ______ 04 NARRATIVE DESCRIPTION

Volatile and semivolatile compounds in excess of 2360 gallons have been released to the environment through various tank and service line failures. Attachment A, B

01 [X] N. DAMAGE TO OFFSITE PROPERTY — 02 ☐ OBSERVED (DATE ______) [X] POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

Groundwater discharges and seeps to surface water may potentially contaminate property down stream with volatile and semivolatile organic compounds. Attachment C

01 ☐ O. CONTAMINATION OF SEWERS, STORM DRAINS, WWTPs — 02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

The potential for contamination of storm sewers does not exist.

01 ☐ P. ILLEGAL/UNAUTHORIZED DUMPING — 02 ☐ OBSERVED (DATE ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

There are no reports of unauthorized dumping within State and local files.

05 DESCRIPTION OF ANY OTHER KNOWN, POTENTIAL, OR ALLEGED HAZARDS

The Benjamin Moore Company was the previous property owners (1920-1962) which constructed a myriad of underground clay tile pipe and underground tanks which may still contain product.

III. TOTAL POPULATION POTENTIALLY AFFECTED: ______

IV. COMMENTS

V. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

See reference sheet for a list of attachments.

UNION CHEMICALS - DIVISION OF UNION OIL CO.
350 ROOSEVELT AVENUE
CARTERET BOROUGH/MIDDLESEX COUNTY
NEW JERSEY
EPA # NJD063173280

The Union Chemicals Company is an active facility on a 4.4 acre parcel of land in Carteret Borough, Middlesex County. The facility is located in a heavily industrialized section of Carteret Borough and is owned and operated by Union Oil Company of California, AKA: American Mineral Spirits Co. The property is bounded by Noes Creek to the south, New Jersey Branch railroad tracks to the west, Roosevelt Avenue to the east, and the Wheeler Condenser and Engineering Company to the north. Development of this parcel of land began in 1920. The Benjamin Moore Company owned the property and operated until 1962 when Union Chemicals purchased the facility primarily for bulk storage and repackaging. In the years 1969 to 1984, anhydrous anmonia was processed to ammonia. Today, approximately 125 different products are handled at the facility, most of which are solvents.

The geology of the area is characterized by the Triassic Brunswick Formation, composed of soft red shale with sandstone beds, however, the Union Chemicals site is not consistent with the surrounding area. The facility is contructed on fill material which ranges in thickness from zero to fifteen feet and is composed of fine to coarse sand with gravel, clay, bricks, concrete, metal, glass, and slag. Beneath the fill are irregular deposits of sands, clays, silty clays, silt and peat which was probably deposited as a result of meandering and ensizing by Noes Creek. The movement of ground water flows from north to south across the site in the direction of Noes Creek.

The Union Chemicals facility has a past history of several product releases to the environment. The first major spill occurred on 2-17-83 when approximately 1860 gallons of MEK, petroluem napthalene, and propyl alcohol leaked into Noes Creek. This occurred as a result of a failure of an underground pipeline which was connected to a 12,000 gallon above ground tank. The second major spill occurred on 7-1-85 when approximately 500 gallons of xylene, toluene, napthalene, and benzene were also released into Noes Creek as a result of a failure in a 10,000 gallon underground tank (Tank #7). The leak was first noted by plant personnel as a large oil sheen on the creek and was traced to a 6" clay tile pipe adjacent to the creek bank. A review of the plant blue prints did not indicate any pipes of that material on the plant grounds. The pipe is believed to have been installed by the Benjamin Moore Company which formerly owned the site. To date, this pipe has not been removed from the site.

Union Chemicals contracted IT Corporation to conduct a site-assessment because of several product releases to the environment. IT installed twelve monitoring wells for ground water monitoring and to assess the direction and rate of ground water flow. The ground water sampling and quantitative analysis revealed significant (greater than 100,000 ppb) levels of xylene, toluene, benzene and chlorobenzene. Many other volatile organic compounds were also detected in smaller concentrations.

At present no remediation of the soil and ground water has been conducted. The USEPA has reviewed the work plan prepared by IT Corporation and determined that additional site information was needed to determine the full extent of contamination. The NJDEP/DHWM/Bureau of Field Operations has recommended that this case be closed because the site is being surpervised by the USEPA.

It is recommended that no further action be taken at the present time due to current investigations conducted by USEPA and IT Corporation. However, a future follow up investigation is recommended to assess the extent of remediation at the site.

Submitted by:

Frank Faranca, HSMS IV
NJDEP/DHWM/BPA
MSCA Project

Hours worked: 40 hours

REFERENCE NO. 2

UNION CHEMICAL
02-8804-09
TDD MGR.- G. CALABRESE
LOGBOOK #0402
FEBRUARY 9, 1989

Union Chemical

TDD # 02-8804-09

Table of Contents

02-8804-09
3-7-89
Union Chemical

~~15-20°F~~ 18°F G.C. Cold
Cloudy ~~20-25-30~~ G.C. winds ~~from~~ from North G.C.
non-sampling
site Investigation

Left NUS at 0910

Arrive at Union Chemical 1155 AM

set-up Decon area at 1010

Held safety meeting at 1030

The following individuals have read the workplan and understood all the Q/A requirements:

1. Winthrop Frame / support
2. MMVogel / SSO
3. Glenn A. Calabrese / SM

#
SCBA - 428552
192063
307176

OVA -
EPA serial No. 469783

HNU -
" " 307144

mini-Alert - " " 428388

Glenn A. Calabrese 3-7-89
MMVogel 3-7-89

02-8804-09 3-7-89

MR. SERGIO LEONE ACCOMPANIED US ON SITE.

1045 - WALKED AROUND ON SITE AND PICTURES ARE BEING TAKEN.

11:00 - CONTINUED TO WALK & TOOK MORE PHOTOS.

11:15 THE TEAM WENT BACK TO THE VEHICLE & WARMED UP. The winds are strong and cold conditions exist.

11:30 WENT BACK OUT ON SITE & TOOK MORE PHOTOS.

11:45 DECON PERSONNEL AND LOADED THE TRUCK.

12:00-12:10 ~~1200~~ TALKED TO MR. LEONE ABOUT SITE INFORMATION & DEPARTED SITE.

As we arrived on site, the plant was found to be active. Mr. Leone accompanied us everywhere we went on site. As pictures 1, 2, and 3 were taken, I notice 2 large (6FT HIGH) black holding tubs that were used in the PUMPING OF GROUNDWATER THAT IS ~~filtered through~~ carbon in this tanks. I noticed the creek (NOCS) to be in a poorly kept condition. Though the maintaince of the creek is ~~a~~ probably not Union Chemical's responsibility. As we walked over to the vertical tanks northwest of the site, pictures 7-10 were taken. The pipes that once fed underground in 1985, were now removed. The contaminated soil was still ~~[illegible]~~ 6" present on site.

[illegible] Calahan
3-7-89

[illegible]

02-8804-09 3-7-89

I could not visually see the contaminated 7
soil, due to it being snow covered.
The snow covered the entire site. These
vertical tank's are presently empty and are
undergoing refinishing. The vertical ~~tanks that~~ G.C.
bulk storage tanks ~~and was~~ G.C. were the cause
of the spill of 1988. PHOTOS 11-18 were taken
of the tanks and spill area. Tank # 223 is the
tank which ~~caused~~ G.C. the spill liquid (1,1,1-Trichloroethane)
derived from. The pipes that ruptured above
ground has been disconnected from tank # 223.
The majority of the pipe has been removed from
the area. The contaminant soil was removed until
clay was reached. The area has been filled in
with a soft songy material. ~~This soil was~~
~~visually inspected by the site manager.~~ G.C.
After the completion of the visual inspection of the
site, Mr Leone and myself discussed the ~~overview~~ G.C. general situation of
the site. ~~General~~ G.C.

Photo log

1	well #1 & 2	1045
2	Noes creek	1049
3	Noes creek	1053
4.	Noes creek	1054
5.	Noes creek	1058
6.	mud - creek	1059
7.	spill 1985 #7 above with Pipes	1105
8.	Tanks #7	1106
9.	spill area of 1985	1113
10.	overview of Tanks	1113
11.	111, - Trich spill 1985	~~[illegible]~~ 1120
12.	spill area	1120
13.	spill area	1120
14.	Tanks of 325 spill out	1125
15.	Pipe outlet	1126
16.	spill area of 1987 111, Trich	1127
17.		1127
18.		
19.	well # 6	1129
20.		1130

Glenn A. Calahan

REFERENCE NO. 3

Nanco Sample ID: 88-SS-3230

Client Sample ID: SB-1

****

NANCO LABS, INC.

****

QUANTITATIVE RESULTS AND QUALITY ASSURANCE DATA

WOODWARD-CLYDE CONSULTANT
547 N. MONROE ST.,SUITE 201
TALLAHASSE, FL. 32301

Date Received: 09/27/88
Date Reported: 11/04/88

PRIORITY POLLUTANT FRACTION
VOLATILE COMPOUNDS BY GC/MS

MEDIUM LEVEL SOIL
DILUTIONOF 1:125

Nanco Sample ID: 88-SS-3230

Customer Sample ID: SB - 1

		RESULTS		Q.C. BLANK	Q.C. MATRIX SPIKE			
CAS #	COMPOUNDS	SAMP. CONC. *UG/KG	MRL. *UG/KG	BLANK UG/KG	UNSPIKED SAMPLE UG/KG	CONC. ADDED UG/KG	SPIKE % RECOVERY	SPIKE DUP. % RECOVERY
71432	BENZENE	BMRL	625	N.D.	N.D.	50	104	114
75274	BROMODICHLOROMETHANE	N.D.	625	N.D.	N.D.	---	---	---
75252	BROMOFORM	N.D.	625	N.D.	N.D.	---	---	---
74839	BROMOMETHANE	N.D.	1,250	N.D.	N.D.	---	---	---
56235	CARBON TETRACHLORIDE	N.D.	625	N.D.	N.D.	---	---	---
108907	CHLOROBENZENE	17,000	625	N.D.	N.D.	50	131	133
75003	CHLOROETHANE	N.D.	1,250	N.D.	N.D.	---	---	---
110758	2-CHLOROETHYLVINYL ETHER	N.D.	1,250	N.D.	N.D.	---	---	---
67663	CHLOROFORM	N.D.	625	N.D.	BMRL	---	---	---
74873	CHLOROMETHANE	N.D.	1,250	N.D.	N.D.	---	---	---
124481	DIBROMOCHLOROMETHANE	N.D.	625	N.D.	N.D.	---	---	---
95501	1,2-DICHLOROBENZENE	N.D.	625	N.D.	N.D.	---	---	---
541731	1,3-DICHLOROBENZENE	N.D.	625	N.D.	N.D.	---	---	---
106467	1,4-DICHLOROBENZENE	N.D.	625	N.D.	N.D.	---	---	---
75343	1,1-DICHLOROETHANE	N.D.	625	N.D.	N.D.	---	---	---
107062	1,2-DICHLOROETHANE	N.D.	625	N.D.	N.D.	---	---	---
75354	1,1-DICHLOROETHENE	N.D.	625	N.D.	N.D.	50	162	131
156605	TRANS-1,2-DICHLOROETHENE	N.D.	625	N.D.	N.D.	---	---	---
78875	1,2-DICHLOROPROPANE	N.D.	625	N.D.	N.D.	---	---	---
10061015	CIS-1,3-DICHLOROPROPENE	N.D.	625	N.D.	N.D.	---	---	---
10061026	TRANS-1,3-DICHLOROPROPENE	N.D.	625	N.D.	N.D.	---	---	---
100414	ETHYLBENZENE	630	625	N.D.	N.D.	---	---	---
75092	METHYLENE CHLORIDE	1,500	625	1,100	22	---	---	---
79345	1,1,2,2-TETRACHLOROETHANE	N.D.	625	N.D.	N.D.	---	---	---
127184	TETRACHLOROETHENE	N.D.	625	N.D.	N.D.	---	---	---
108883	TOLUENE	N.D.	625	N.D.	N.D.	50	142	131
71556	1,1,1-TRICHLOROETHANE	N.D.	625	N.D.	N.D.	---	---	---
79005	1,1,2-TRICHLOROETHANE	N.D.	625	N.D.	9	---	---	---
79016	TRICHLOROETHENE	N.D.	625	N.D.	11	50	121	135
75694	TRICHLOROFLUOROMETHANE	N.D.	625	N.D.	N.D.	---	---	---
75014	VINYL CHLORIDE	N.D.	1,250	N.D.	N.D.	---	---	---

N.D. = Not Detected BMRL = Below Minimum Reporting Level MRL = Minimum Reporting Level

* RESULTS ARE BASED ON DRY WEIGHT

NANCO LABS, INC.

QUANTITATIVE RESULTS AND QUALITY ASSURANCE DATA

WOODWARD-CLYDE CONSULTANT

Date Received: 09/27/88
Date Reported: 11/09/88

METALS

Nanco Sample ID: 88-SS-3230 Customer Sample ID: SB-1

# COMPOUNDS	RESULTS		Q.C. REPLICATES		Q.C. BLANK & SPIKED BLANK			Q.C. MATRIX SPIKE		
	SAMP. CONC. *MG/KG	MRL. *MG/KG	FIRST UG/L	SECOND UG/L	BLANK UG/L	CONC. ADDED UG/L	% RECOVERY	UNSPIKED SAMPLE UG/L	CONC. ADDED UG/L	% RECOVERY
ANTIMONY	BMRL	15	BMRL	BMRL	ND	1,010	101	BMRL	500	90
ARSENIC	47.8	2.4	BMRL	BMRL	ND	47.0	106	BMRL	20	200
BERYLLIUM	1.2	1.2	ND	ND	ND	481	105	ND	50	96
CADMIUM	BMRL	1.2	BMRL	BMRL	ND	489	103	ND	50	94
CHROMIUM	37	2.4	BMRL	BMRL	ND	506	107	BMRL	200	96
COPPER	59	6.1	BMRL	BMRL	ND	542	101	BMRL	250	99
LEAD	160	1.2	36	35	ND	24.5	106	BMRL	20	95
MERCURY	0.17	0.12	BMRL	ND	ND	5.2	108	BMRL	1	90
NICKEL	BMRL	9.8	ND	ND	ND	496	101	ND	400	108
SELENIUM	BMRL	1.2	BMRL	BMRL	ND	26.0	92	BMRL	10	86
SILVER	ND	2.4	ND	ND	ND	509	94	ND	50	80
THALLIUM	BMRL	2.4	ND	ND	ND	24.3	100	ND	50	84
ZINC	407	4.9	182	183	ND	3,100	96	228	200	244
% SOLIDS	82	----	----	----	----	----	----	----	----	----

N.D. = Not Detected BMRL = Below Minimum Reporting Level MRL = Minimum Reporting Level

* RESULTS ARE BASED ON DRY WEIGHT

****
NANCO LABS, INC.
****

Surrogate Recovery - GC/MS Data

00023

SOIL

Nanco ID: 88-SS-3230 Date sample received: 09/27/88

Compound	Amount Added ug/kg	% Recovery	Control Limits % Lower	Upper
VOLATILE FRACTION				
Bromofluorobenzene	50	103	74	121
1,2 Dichloroethane d4	50	102	70	121
Toluene d8	50	93	81	117

Nanco Sample ID: 88-SS-3231

Client Sample ID: SB-3

****

NANCO LABS, INC.

****

QUANTITATIVE RESULTS AND QUALITY ASSURANCE DATA

00030

WOODWARD-CLYDE CONSULTANT
547 N. MONROE ST.,SUITE 201
TALLAHASSE, FL. 32301

Date Received: 09/27/88
Date Reported: 11/04/88

PRIORITY POLLUTANT FRACTION
VOLATILE COMPOUNDS BY GC/MS

MEDIUM LEVEL SOIL
DILUTIONOF 1:125

Nanco Sample ID: 88-SS-3231

Customer Sample ID: SB - 3

CAS #	COMPOUNDS	RESULTS SAMP. CONC. *UG/KG	MRL. *UG/KG	Q.C. BLANK BLANK UG/KG	Q.C. MATRIX SPIKE UNSPIKED SAMPLE UG/KG	CONC. ADDED UG/KG	SPIKE % RECOVERY	SPIKE DUP. % RECOVERY
71432	BENZENE	850	625	N.D.	N.D.	50	104	114
75274	BROMODICHLOROMETHANE	N.D.	625	N.D.	N.D.	---	---	---
75252	BROMOFORM	N.D.	625	N.D.	N.D.	---	---	---
74839	BROMOMETHANE	N.D.	1,250	N.D.	N.D.	---	---	---
56235	CARBON TETRACHLORIDE	N.D.	625	N.D.	N.D.	---	---	---
108907	CHLOROBENZENE	N.D.	625	N.D.	N.D.	50	131	133
75003	CHLOROETHANE	N.D.	1,250	N.D.	N.D.	---	---	---
110758	2-CHLOROETHYLVINYL ETHER	N.D.	1,250	N.D.	N.D.	---	---	---
67663	CHLOROFORM	N.D.	625	N.D.	BMRL	---	---	---
74873	CHLOROMETHANE	N.D.	1,250	N.D.	N.D.	---	---	---
124481	DIBROMOCHLOROMETHANE	N.D.	625	N.D.	N.D.	---	---	---
95501	1,2-DICHLOROBENZENE	N.D.	625	N.D.	N.D.	---	---	---
541731	1,3-DICHLOROBENZENE	N.D.	625	N.D.	N.D.	---	---	---
106467	1,4-DICHLOROBENZENE	N.D.	625	N.D.	N.D.	---	---	---
75343	1,1-DICHLOROETHANE	N.D.	625	N.D.	N.D.	---	---	---
107062	1,2-DICHLOROETHANE	N.D.	625	N.D.	N.D.	---	---	---
75354	1,1-DICHLOROETHENE	N.D.	625	N.D.	N.D.	50	162	131
156605	TRANS-1,2-DICHLOROETHENE	N.D.	625	N.D.	N.D.	---	---	---
78875	1,2-DICHLOROPROPANE	N.D.	625	N.D.	N.D.	---	---	---
10061015	CIS-1,3-DICHLOROPROPENE	N.D.	625	N.D.	N.D.	---	---	---
10061026	TRANS-1,3-DICHLOROPROPENE	N.D.	625	N.D.	N.D.	---	---	---
100414	ETHYLBENZENE	2,600	625	N.D.	N.D.	---	---	---
75092	METHYLENE CHLORIDE	4,900	625	1,100	22	---	---	---
79345	1,1,2,2-TETRACHLOROETHANE	N.D.	625	N.D.	N.D.	---	---	---
127184	TETRACHLOROETHENE	N.D.	625	N.D.	N.D.	---	---	---
108883	TOLUENE	BMRL	625	N.D.	N.D.	50	142	131
71556	1,1,1-TRICHLOROETHANE	N.D.	625	N.D.	N.D.	---	---	---
79005	1,1,2-TRICHLOROETHANE	N.D.	625	N.D.	9	---	---	---
79016	TRICHLOROETHENE	N.D.	625	N.D.	11	50	121	135
75694	TRICHLOROFLUOROMETHANE	N.D.	625	N.D.	N.D.	---	---	---
75014	VINYL CHLORIDE	N.D.	1,250	N.D.	N.D.	---	---	---

N.D. = Not Detected   BMRL = Below Minimum Reporting Level   MRL = Minimum Reporting Level

* RESULTS ARE BASED ON DRY WEIGHT

****

NANCO LABS, INC.

****

QUANTITATIVE RESULTS AND QUALITY ASSURANCE DATA

00031

WOODWARD-CLYDE CONSULTANT

Date Received: 09/27/88
Date Reported: 11/09/88

METALS

Nanco Sample ID: 88-SS-3231 Customer Sample ID: SB-3

# COMPOUNDS	RESULTS		Q.C. REPLICATES		Q.C. BLANK & SPIKED BLANK			Q.C. MATRIX SPIKE		
	SAMP. CONC. *MG/KG	MRL. *MG/KG	FIRST UG/L	SECOND UG/L	BLANK UG/L	CONC. ADDED UG/L	% RECOVERY	UNSPIKED SAMPLE UG/L	CONC. ADDED UG/L	% RECOVERY
ANTIMONY	BMRL	14	BMRL	BMRL	ND	1,010	101	BMRL	500	90
ARSENIC	5.0	2.4	BMRL	BMRL	ND	47.0	106	BMRL	20	200
BERYLLIUM	1.4	1.2	ND	ND	ND	481	105	ND	50	96
CADMIUM	BMRL	1.2	BMRL	BMRL	ND	489	103	ND	50	94
CHROMIUM	12	2.4	BMRL	BMRL	ND	506	107	BMRL	200	96
COPPER	43	6.0	BMRL	BMRL	ND	542	101	BMRL	250	99
LEAD	59	1.2	36	35	ND	24.5	106	BMRL	20	95
MERCURY	BMRL	0.12	BMRL	ND	ND	5.2	108	BMRL	1	90
NICKEL	BMRL	9.5	ND	ND	ND	496	101	ND	400	108
SELENIUM	BMRL	1.2	BMRL	BMRL	ND	26.0	92	BMRL	10	86
SILVER	ND	2.4	ND	ND	ND	509	94	ND	50	80
THALLIUM	ND	2.4	ND	ND	ND	24.3	100	ND	50	84
ZINC	101	4.8	182	183	ND	3,100	96	228	200	244
% SOLIDS	84	----	----	----	----	----	----	----	----	----

N.D. = Not Detected BMRL = Below Minimum Reporting Level MRL = Minimum Reporting Level

* RESULTS ARE BASED ON DRY WEIGHT

****

NANCO LABS, INC.

****

Surrogate Recovery - GC/MS Data

SOIL

Nanco ID: 88-SS-3231 Date sample received: 09/27/88

Compound	Amount Added ug/kg	% Recovery	Control Limits % Lower	Upper
VOLATILE FRACTION				
Bromofluorobenzene	50	103	74	121
1,2 Dichloroethane d4	50	97	70	121
Toluene d8	50	113	81	117

Nanco Sample ID: 88-SS-3233

Client Sample ID: SB-6

****

NANCO LABS, INC.

****

QUANTITATIVE RESULTS AND QUALITY ASSURANCE DATA

00046

WOODWARD-CLYDE CONSULTANT
547 N. MONROE ST.,SUITE 201
TALLAHASSE, FL. 32301

Date Received: 09/27/88
Date Reported: 11/04/88

PRIORITY POLLUTANT FRACTION
VOLATILE COMPOUNDS BY GC/MS

MEDIUM LEVEL SOIL
DILUTIONOF 1:125

Nanco Sample ID: 88-SS-3233

Customer Sample ID: SB - 6

CAS #	COMPOUNDS	RESULTS SAMP. CONC. *UG/KG	RESULTS MRL. *UG/KG	Q.C. BLANK BLANK UG/KG	Q.C. MATRIX SPIKE UNSPIKED SAMPLE UG/KG	CONC. ADDED UG/KG	SPIKE % RECOVERY	SPIKE DUP. % RECOVERY
71432	BENZENE	N.D.	625	N.D.	N.D.	50	104	114
75274	BROMODICHLOROMETHANE	N.D.	625	N.D.	N.D.	---	---	---
75252	BROMOFORM	N.D.	625	N.D.	N.D.	---	---	---
74839	BROMOMETHANE	N.D.	1,250	N.D.	N.D.	---	---	---
56235	CARBON TETRACHLORIDE	N.D.	625	N.D.	N.D.	---	---	---
108907	CHLOROBENZENE	4,500	625	N.D.	N.D.	50	131	133
75003	CHLOROETHANE	N.D.	1,250	N.D.	N.D.	---	---	---
110758	2-CHLOROETHYLVINYL ETHER	N.D.	1,250	N.D.	N.D.	---	---	---
67663	CHLOROFORM	N.D.	625	N.D.	BMRL	---	---	---
74873	CHLOROMETHANE	N.D.	1,250	N.D.	N.D.	---	---	---
124481	DIBROMOCHLOROMETHANE	N.D.	625	N.D.	N.D.	---	---	---
95501	1,2-DICHLOROBENZENE	N.D.	625	N.D.	N.D.	---	---	---
541731	1,3-DICHLOROBENZENE	N.D.	625	N.D.	N.D.	---	---	---
106467	1,4-DICHLOROBENZENE	N.D.	625	N.D.	N.D.	---	---	---
75343	1,1-DICHLOROETHANE	N.D.	625	N.D.	N.D.	---	---	---
107062	1,2-DICHLOROETHANE	N.D.	625	N.D.	N.D.	---	---	---
75354	1,1-DICHLOROETHENE	N.D.	625	N.D.	N.D.	50	162	131
156605	TRANS-1,2-DICHLOROETHENE	N.D.	625	N.D.	N.D.	---	---	---
78875	1,2-DICHLOROPROPANE	N.D.	625	N.D.	N.D.	---	---	---
10061015	CIS-1,3-DICHLOROPROPENE	N.D.	625	N.D.	N.D.	---	---	---
10061026	TRANS-1,3-DICHLOROPROPENE	N.D.	625	N.D.	N.D.	---	---	---
100414	ETHYLBENZENE	1,100	625	N.D.	N.D.	---	---	---
75092	METHYLENE CHLORIDE	1,200	625	1,100	22	---	---	---
79345	1,1,2,2-TETRACHLOROETHANE	N.D.	625	N.D.	N.D.	---	---	---
127184	TETRACHLOROETHENE	N.D.	625	N.D.	N.D.	---	---	---
108883	TOLUENE	BMRL	625	N.D.	N.D.	50	142	131
71556	1,1,1-TRICHLOROETHANE	N.D.	625	N.D.	N.D.	---	---	---
79005	1,1,2-TRICHLOROETHANE	N.D.	625	N.D.	9	---	---	---
79016	TRICHLOROETHENE	N.D.	625	N.D.	11	50	121	135
75694	TRICHLOROFLUOROMETHANE	N.D.	625	N.D.	N.D.	---	---	---
75014	VINYL CHLORIDE	N.D.	1,250	N.D.	N.D.	---	---	---

N.D. = Not Detected   BMRL = Below Minimum Reporting Level   MRL = Minimum Reporting Level

* RESULTS ARE BASED ON DRY WEIGHT

****
NANCO LABS, INC.
****

QUANTITATIVE RESULTS AND QUALITY ASSURANCE DATA

00047

WOODWARD-CLYDE CONSULTANT

Date Received: 09/27/88
Date Reported: 11/09/88

METALS

Nanco Sample ID: 88-SS-3233 — Customer Sample ID: SB-6

	RESULTS		Q.C. REPLICATES		Q.C. BLANK & SPIKED BLANK			Q.C. MATRIX SPIKE		
# COMPOUNDS	SAMP. CONC. *MG/KG	MRL. *MG/KG	FIRST UG/L	SECOND UG/L	BLANK UG/L	CONC. ADDED UG/L	% RECOVERY	UNSPIKED SAMPLE UG/L	CONC. ADDED UG/L	% RECOVERY
ANTIMONY	25	14	BMRL	BMRL	ND	1,010	101	BMRL	500	90
ARSENIC	3.6	2.4	BMRL	BMRL	ND	47.0	106	BMRL	20	200
BERYLLIUM	2.1	1.2	ND	ND	ND	481	105	ND	50	96
CADMIUM	1.4	1.2	BMRL	BMRL	ND	489	103	ND	50	94
CHROMIUM	18	2.4	BMRL	BMRL	ND	506	107	BMRL	200	96
COPPER	188	6.0	BMRL	BMRL	ND	542	101	BMRL	250	99
LEAD	62	1.2	36	35	ND	24.5	106	BMRL	20	95
MERCURY	BMRL	0.12	BMRL	ND	ND	5.2	108	BMRL	1	90
NICKEL	11	9.5	ND	ND	ND	496	101	ND	400	108
SELENIUM	ND	1.2	BMRL	BMRL	ND	26.0	92	BMRL	10	86
SILVER	ND	2.4	ND	ND	ND	509	94	ND	50	80
THALLIUM	ND	2.4	ND	ND	ND	24.3	100	ND	50	84
ZINC	220	4.8	182	183	ND	3,100	96	228	200	244
% SOLIDS	84	----	----	----	----	----	----	----	----	----

N.D. = Not Detected BMRL = Below Minimum Reporting Level MRL = Minimum Reporting Level
* RESULTS ARE BASED ON DRY WEIGHT

****
NANCO LABS, INC.
****

Surrogate Recovery - GC/MS Data

SOIL

Nanco ID: 88-SS-3233 Date sample received: 09/27/88

Compound	Amount Added ug/kg	% Recovery	Control Limits % Lower	Upper
VOLATILE FRACTION				
Bromofluorobenzene	50	100	74	121
1,2 Dichloroethane d4	50	105	70	121
Toluene d8	50	101	81	117

****

NANCO LABS, INC.

****

WOODWARD & CLYDE CONSULTANT

Date Received: 11/14/88
Date Reported: 11/22/88

E.P. TOXICITY METALS

Nanco ID: 88-SS-4779 Customer ID: SB - 1

#	COMPOUNDS	RESULTS	UNITS	MCL
1M	ARSENIC	< 0.05	MG/L	5.0
2M	BARIUM	0.39	MG/L	100
3M	CADMIUM	0.006	MG/L	1.0
4M	CHROMIUM	0.053	MG/L	5.0
5M	LEAD	0.617	MG/L	5.0
6M	MERCURY	< 0.0002	MG/L	0.2
7M	SELENIUM	< 0.075	MG/L	1.0
8M	SILVER	< 0.01	MG/L	5.0

MCL = MAXIMUM CONTAMINATION LEVEL

****
NANCO LABS, INC.
****

WOODWARD & CLYDE CONSULTANT

Date Received: 11/14/88
Date Reported: 11/22/88

E.P. TOXICITY METALS

Nanco ID: 88-SS-4780 Customer ID: SB - 3

#	COMPOUNDS	RESULTS	UNITS	MCL
1M	ARSENIC	< 0.05	MG/L	5.0
2M	BARIUM	0.632	MG/L	100
3M	CADMIUM	< 0.005	MG/L	1.0
4M	CHROMIUM	< 0.01	MG/L	5.0
5M	LEAD	0.188	MG/L	5.0
6M	MERCURY	< 0.0002	MG/L	0.2
7M	SELENIUM	< 0.075	MG/L	1.0
8M	SILVER	< 0.01	MG/L	5.0

MCL = MAXIMUM CONTAMINATION LEVEL

****

NANCO LABS, INC.

****

WOODWARD & CLYDE CONSULTANT

Date Received: 11/14/88
Date Reported: 11/22/88

E.P. TOXICITY METALS

Nanco ID: 88-SS-4781 Customer ID: SB - 4

#	COMPOUNDS	RESULTS	UNITS	MCL
1M	ARSENIC	< 0.05	MG/L	5.0
2M	BARIUM	0.316	MG/L	100
3M	CADMIUM	0.009	MG/L	1.0
4M	CHROMIUM	< 0.01	MG/L	5.0
5M	LEAD	0.348	MG/L	5.0
6M	MERCURY	< 0.0002	MG/L	0.2
7M	SELENIUM	< 0.075	MG/L	1.0
8M	SILVER	< 0.01	MG/L	5.0

MCL = MAXIMUM CONTAMINATION LEVEL

****

NANCO LABS, INC.

****

WOODWARD & CLYDE CONSULTANT

Date Received: 11/14/88
Date Reported: 11/22/88

E.P. TOXICITY METALS

Nanco ID: 88-SS-4782   Customer ID: SB - 6

#	COMPOUNDS	RESULTS	UNITS	MCL
1M	ARSENIC	< 0.05	MG/L	5.0
2M	BARIUM	0.493	MG/L	100
3M	CADMIUM	< 0.005	MG/L	1.0
4M	CHROMIUM	< 0.01	MG/L	5.0
5M	LEAD	0.262	MG/L	5.0
6M	MERCURY	< 0.0002	MG/L	0.2
7M	SELENIUM	< 0.075	MG/L	1.0
8M	SILVER	< 0.01	MG/L	5.0

MCL = MAXIMUM CONTAMINATION LEVEL

REFERENCE NO. 4

0026C
02-8804-09

NUS CORPORATION AND SUBSIDIARIES — **TELECON NOTE**

CONTROL NO:	DATE:	TIME:
02-8804-09	3-9-89	1440

DISTRIBUTION:

Site Information

BETWEEN:	OF:	PHONE:
Mr. Myron Wolansky	Union Chemical	(201) 574-9300

AND:

Glenn A. Calabrese

DISCUSSION:

Mr. Wolansky discussed surface water data, a spilling of 1987 or 1985, and the location of the spill with myself. He will search out additional information for further discussion with me.

ACTION ITEMS:

NUS 087 REVISED 0685

REFERENCE NO. 5

CO28C
02-8804-09

NUS CORPORATION — **TELECON NOTE**

CONTROL NO:	DATE:	TIME:
02-8804-09	3-10-89	1500

DISTRIBUTION:

Site Information

BETWEEN:	OF:	PHONE:
MR. DARYL DIERWECHTER	Union CHemical	(312) 619-2613

AND: Glenn A. Calabrese (NUS)

DISCUSSION:

Mr. Dierwechter supplied me with the following information: In spill #3 of-1988, soil was removed down to the clay layers (3 feet down). This was a reddish-brown color clay.
He will send me a copy of IT's second report.
He will send the surface water sample table.

ACTION ITEMS: He will call back on 3-13-89.

REFERENCE NO. 6

0029C
02-8804-09

NUS CORPORATION AND SUBSIDIARIES — **TELECON NOTE**

CONTROL NO:	DATE:	TIME:
02-8804-09	3-10-89	11 30

DISTRIBUTION:

Site Information

BETWEEN:	OF:	PHONE:
Mr. Myron Wolansky	Union Chemical	(201) 574-9300

AND: Mr. Glenn A. Calabrese

DISCUSSION:

Mr. Wolansky explained the 83' spill in detail to me. The 85 and the 88 spills were confirmed by Mr. Wolansky. He also went into detail about those spills.

ACTION ITEMS:

NUS 087 REVISED 0885

REFERENCE NO. 7

0031-C
02-8804-09

NUS CORPORATION

TELECON NOTE

CONTROL NO: 02-8804-09

DATE: 3-16-89

TIME: 1400

DISTRIBUTION:

Site Information

BETWEEN: MR. DARYL DIERWECHTER

OF: Union Chemicals

PHONE: (312) 619-2613

AND: Glenn A Calabrese (NUS)

DISCUSSION:

1985 spill of xylene contaminated groundwater. Most of the spill was recovered. Underground rupture of a pipe (Transit.) was the cause of the leakage to groundwater. A log will be sent to me documenting the spill of 1985 by Union chemicals plant manager in 1985; at the time of the spill. Daryl will send me the second report by IT. The report will supply me with the ~~water~~ S.C. surface water samples of Noes Creek. All 18 monitoring wells were placed in by IT. Union Chemical is awaiting removal plans of soil by the State. The 1985 & 1983 spill occurred in the same general locations. Groundwater is 2 FT below the surface. Both spills came from Tank #7.

ACTION ITEMS:

REFERENCE NO. 8

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

BOROUGH OF
CARTERET, NEW JERSEY
MIDDLESEX COUNTY

COMMUNITY-PANEL NUMBER
340257 0005 A

(ONLY PANEL PRINTED)

EFFECTIVE
NOVEMBER 15, 1978

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FEDERAL INSURANCE ADMINISTRATION

REFERENCE NO. 9

ATTACHMENT A

QUARTERLY SAMPLING RESULTS
JANUARY, 1989
UNOCAL CHEMICALS
CARTERET, NEW JERSEY
NJPDES #0026077

REGULATORY FORMS: GROUNDWATER ANALYSES
MONITORING WELL REPORTS
(FORM T-VWX-014, FORM VWX-015A, FORM VWX-015B,
FORM VWX-016, FORM VWX-017)

Woodward-Clyde Consultants

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIROMENTAL SCIENTISTS
547 NORTH MONROE, SUITE 201 TALLAHASSEE, FLORIDA 32301

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month ☐☐ Year ☐☐

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

MONITORING REPORT — TRANSMITTAL SHEET

NJPDES NO.	REPORTING PERIOD MO. YR.		MO. YR.
0 0 2 6 0 7 7	1 1 8 8	THRU	0 1 8 9

PERMITTEE:
Name: Unocal Chemical
Address: 1345 North Meacham Road
Schaumburg, IL 60196

FACILITY:
Name: Unocal Chemicals Division
Address: 350 Roosevelt Avenue
Carteret (County) Middlesex
Telephone: (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY
[ ] T-VWX-007 [ ] T-VWX-008 [ ] T-VWX-009

SLUDGE REPORTS - INDUSTRIAL
[ ] T-VWX-010A [ ] T-VWX-010B

WASTEWATER REPORTS
[ ] T-VWX-011 [ ] T-VWX-012 [ ] T-VWX-013

GROUNDWATER REPORTS
[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT
[ ] EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	[ ]	[X]
TEMPORARY BYPASSING	[ ]	[X]
DISINFECTION INTERRUPTION	[ ]	[X]
MONITORING MALFUNCTIONS	[ ]	[X]
UNITS OUT OF OPERATION	[ ]	[X]
OTHER	[ ]	[X]

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inqu of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are signific penalties for submitting false information including the possibility of fine and imprison

LICENSED OPERATOR
Name *(Printed)*
Grade & Registry No.
Signature
Date

PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE
Name *(Printed)*: Daryl W. Dierwechter
Title *(Printed)*: Supervisor Environmental Affairs
Signature: Daryl W. Dierwechter
Date: March 21, 1989

ATTACHMENT A

QUARTERLY SAMPLING RESULTS
JANUARY, 1989
UNOCAL CHEMICALS
CARTERET, NEW JERSEY
NJPDES #0026077

REGULATORY FORMS: GROUNDWATER ANALYSES
MONITORING WELL REPORTS
(FORM T-VWX-014, FORM VWX-015A, FORM VWX-015B,
FORM VWX-016, FORM VWX-017)

Woodward-Clyde Consultants

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIROMENTAL SCIENTISTS
547 NORTH MONROE, SUITE 201 TALLAHASSEE, FLORIDA 32301

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month

Year

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

MONITORING REPORT – TRANSMITTAL SHEET

NJPDES NO.	REPORTING PERIOD MO. YR.		MO. YR.
0 0 0 2 6 0 0 7 7	1 1 8 8	THRU	0 1 8 9

PERMITTEE: Name Unocal Chemical

Address 1345 North Meacham Road

Schaumburg, IL 60196

FACILITY: Name Unocal Chemicals Division

Address 350 Roosevelt Avenue

Carteret (County) Middlesex

Telephone (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY

[ ] T-VWX-007 [ ] T-VWX-008 [ ] T-VWX-009

SLUDGE REPORTS - INDUSTRIAL

[ ] T-VWX-010A [ ] T-VWX-010B

WASTEWATER REPORTS

[ ] T-VWX-011 [ ] T-VWX-012 [ ] T-VWX-013

GROUNDWATER REPORTS

[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT

[ ] EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	[ ]	[X]
TEMPORARY BYPASSING	[ ]	[X]
DISINFECTION INTERRUPTION	[ ]	[X]
MONITORING MALFUNCTIONS	[ ]	[X]
UNITS OUT OF OPERATION	[ ]	[X]
OTHER	[ ]	[X]

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inqu of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significa penalties for submitting false information including the possibility of fine and imprisonm

LICENSED OPERATOR

Name *(Printed)* ________

Grade & Registry No. ________

Signature ________

Date ________

PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE

Name *(Printed)* Daryl W. Dierwechter

Title *(Printed)* Supervisor Environmental Affairs

Signature Daryl W. Dierwechter

Date March 21, 1989

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month [|] Year [|]

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

MONITORING REPORT — TRANSMITTAL SHEET

NJPDES NO. 0026077 | REPORTING PERIOD MO. YR. 11 88 THRU 01 89

PERMITTEE: Name Unocal Chemical
Address 1345 North Meacham Road
Schaumburg, IL 60196

FACILITY: Name Unocal Chemicals Division
Address 350 Roosevelt Avenue
Carteret (County) Middlesex
Telephone (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY
[ ] T-VWX-007 [ ] T-VWX-008 [ ] T-VWX-009

SLUDGE REPORTS - INDUSTRIAL
[ ] T-VWX-010A [ ] T-VWX-010B

WASTEWATER REPORTS
[ ] T-VWX-011 [ ] T-VWX-012 [ ] T-VWX-013

GROUNDWATER REPORTS
[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT
[ ] EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	[ ]	[X]
TEMPORARY BYPASSING	[ ]	[X]
DISINFECTION INTERRUPTION	[ ]	[X]
MONITORING MALFUNCTIONS	[ ]	[X]
UNITS OUT OF OPERATION	[ ]	[X]
OTHER	[ ]	[X]

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inqu. of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significa penalties for submitting false information including the possibility of fine and imprisonm

LICENSED OPERATOR

Name (Printed) ____________

Grade & Registry No. ____________

Signature ____________

Date ____________

PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE

Name (Printed) Daryl W. Dierwechter

Title (Printed) Supervisor Environmental Affairs

Signature Daryl W. Dierwechter

Date March 21, 1989

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ | SW ID NO: MW-1

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08552-6	89 02 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	umhos/cm		2624	
X			X			X			X			Floating Product	inches		0	
X			X			X			X			Total Xylenes	ug/l		1.2	

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83
P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECT
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-1

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE (YR. / MO. / DAY)	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	26-08552-6	89 02 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

J	F	M	A	M	J	J	A	S	O	N	D	ANALYTES	UNITS	PARAMETER	VALUE	REMARKS
			X						X			Chrysene	ug/1	34320		
												Dibenzanthracene	ug/1	34556		
												1,2-Dichlorobenzene	ug/1	34536		
												1,3-Dichlorobenzene	ug/1	34566		
												1,4-Dichlorobenzene	ug/1	34571		
												3,3'-Dichlorobenzidine	ug/1	34631		
												Diethyl Phthalate	ug/1	34336		
												Dimethyl Phthalate	ug/1	34341		
												Di-n-butyl Phthalate	ug/1	39110		
												2,4-Dinitrotolulene	ug/1	34611		
												2,6-Dinitrotolulene	ug/1	34626		
												Di-n-octyl Phthalate	ug/1	34596		
												1,2-Diphenylhydrazine	ug/1	34346		
												Fluoranthene	ug/1	34376		
												Fluorene	ug/1	34381		
												Hexachlorobenzene	ug/1	39700		
												Hexachlorobutadiene	ug/1	34391		
												Hexachlorocyclopentadiene	ug/1	34386		
												Hexachloroethane	ug/1	34396		
												Indenopyrene	ug/1	34403		
												Isophorone	ug/1	34408		
												Naphthalene	ug/1	34696		
												Nitrobenzene	ug/1	34447		
												N-Nitrosodimethylamine	ug/1	34438		
												N-Nitrosodi-n-propylamine	ug/1	34428		
												N-Nitrosodiphenylamine	ug/1	34433		
												Phenanthrene	ug/1	34461		
												Pyrene	ug/1	34469		
												1,2,4-Trichlorobenzene	ug/1	34551		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical - Carteret, NJ — SW ID NO. MW-1

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

U — NJPDES NO. NJ 0026077 — WELL PERMIT NO. 26-08552-6 — SAMPLE DATE YR. MO. DAY 890207 — NJ LAB CERT. NO. 73460 — WCM USE

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS: Apr X, Oct X

ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
2-Chlorophenol	ug/1	34586		
2,4-Dichlorophenol	ug/1	34601		
2,4-Dimethylphenol	ug/1	34606		
2,6-Dinitro-o-cresol	ug/1	77603		
2,4-Dinitrophenol	ug/1	34616		
2-Nitrophenol	ug/1	34591		
4-Nitrophenol	ug/1	34649		
p-Chloro-m-cresol	ug/1	34452		
Pentachlorophenol	ug/1	39032		
Phenol	ug/1	34695		
2,4,6-Trichlorophenol	ug/1	34621		
Acenaphthene	ug/1	34205		
Acenaphthylene	ug/1	34200		
Anthracene	ug/1	34220		
Benzidine	ug/1	39120		
Benzanthracene	ug/1	34526		
Benzopyrene	ug/1	34247		
3,4-Benzofluoranthene	ug/1	34230		
Benzoperylene	ug/1	34521		
Benzofluoranthene	ug/1	34242		
Bis(2-chloroethoxy)methane	ug/1	34278		
Bis(2-chloroethyl) Ether	ug/1	34273		
Bis(2-chlroisopropyl) Ether	ug/1	34283		
Bis(2-ethylhexyl) Phthalate	ug/1	39100		
4-Bromophenyl Ether	ug/1	34636		
Butylbenzyl Phthalate	ug/1	34292		
2-Chloronaphthalene	ug/1	34581		
4-Chlorophenyl Phenyl Ether	ug/1	34641		

VALUE CODING RULES AND

Form VWX-016
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical - Carteret, NJ | SW ID NO. MW-1

LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	LAB CERT. NO.	WQM USE
T	NJ 0026077	26-08552-6	890207	73460	
1	2–8	9–16	17–22	23–27	28

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Acrylonitrile	UG/L	34215	25	K
												Benzene	UG/L	34030	1	K
												Bromoform	UG/L	32104	1	K
												Carbon Tetrachloride	UG/L	32102	1	K
												Chlorobenzene	UG/L	34301	8.2	
												Chlorodibromoethane	UG/L	34306	1	K
												Chloroform	UG/L	32106	1	K
												1, 1 - Dichloroethane	UG/L	34496	1	K
												1, 2 - Dichloroethane	UG/L	34531	1	K
												1, 1 - Dichloroethylene	UG/L	34501	1	K
												1, 2 - Dichloropropane	UG/L	34541	1	K
												Ethylbenzene	UG/L	34371	1	K
												Methylene Chloride	UG/L	34423	2.8	
												1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	1	K
												Tetrachloroethylene	UG/L	34475	1	K
												Toluene	UG/L	34012	1.9	
												1, 1, 1 - Trichloroethane	UG/L	34506	1	K
												1, 1, 2 - Trichloroethane	UG/L	34511	1	K
												Trichloroethylene	UG/L	39180	1	K
												Vinyl Chloride	UG/L	39175	1	K
												Acrolein	UG/L	34210	25	K
												Chloroethane	UG/L	34311	1	K
												2 - Chloroethylvinyl Ether	UG/L	34576	1	K
												Dichlorobromomethane	UG/L	32105	1	K
												1, 3 - Dichloropropylene	UG/L	34699	1	K
												Methyl Bromide	UG/L	34413	1	K
												Methyl Chloride	UG/L	34418	1	K
												1, 2 - trans - Dichloroethylene	UG/L	34546	1	K
												1, 2 Dichlorobenzene	UG/L	34536	1	K
												1, 3 Dichlorobenzene	UG/L	34566	1	K
												1, 4 Dichlorobenzene	UG/L	34571	1	K
														29 42 55 68 … 33 46 59 72	34 47 60 73 … 40 53 66 79	41 54 67 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ
SW ID NO.: MW-1
LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077	26-08552-6	89 02 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Methoxychlor, Total	UG/L	39480		
												Methylene Blue Active Substances	MG/L	38260		
												Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
												Nitrogen, Nitrate Dissolved	MG/L as N	00618		
												Odor	T.O.N.	00085		
			X									pH	Standard Units	00400	7.22	
												Phenols, Total Recoverable	UG/L	32730		
												Radium 226, Dissolved	Pc/L	09503		
												Radium 228, Dissolved	Pc/L	81366		
												Selenium, Dissolved	UG/L	01145		
												Silver, Dissolved	UG/L	01075		
												Sodium, Dissolved	MG/L	00930		
			X									Sulfate, Dissolved (as SO_4)	MG/L	00945		
X			X			X			X			Total Dissolved Solids (TDS)	PPM	70300	1580	
												Total Organic Carbon (TOC)	PPM	00680		
												Total Organic Halogen (TOX)	UG/L	70353		
												Toxaphene	UG/L	39400		
												Turbidity	NTU	00076		
			X									Zinc, Dissolved	UG/L	01090		
												2, 4–D, Total	UG/L	39370		
												2, 4, 5–TP, Total	UG/L	39045		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-015 A
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ | SW ID NO: MW-1

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0027677	26-08552-6	890207	73460	
1	2 – 8	9 – 16	17 – 22	23 – 27	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE
X			X			X			X			Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		8.27
X			X			X			X			Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		8.98
X			X			X			X			Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	7.52
X			X			X			X			Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	8.23
			X									Arsenic, Dissolved	UG/L as As	01000	
												Barium, Dissolved	UG/L as Ba	01005	
												Biochemical Oxygen Demand - 5 Day	MG/L	00310	
												Cadmium, Dissolved	UG/L as Cd	01025	
X			X			X			X			Chloride, Dissolved	UG/L as Cl	82295	669700
												Chromium, Dissolved	UG/L as Cr	01030	
												Chromium, Dissolved, Hexavalent	UG/L as Cr	01220	
												Chemical Oxygen Demand (COD), Dissolved	MG/L	00341	
												Coliform Group	N/100 ML	74056	
												Color	Pt - Co	00080	
												Copper, Dissolved	UG/L as Cu	01040	
												Cyanide, Total	MG/L as CN	00720	
												Endrin, Total	UG/L	39390	
												Fluoride, Dissolved	MG/L as F	00950	
												Gross Alpha, Dissolved	Pc/L	01503	
												Gross Beta, Dissolved	Pc/L	03503	
												Hardness, Total as $CaCO_3$	MG/L	00900	
												Iron, Dissolved	UG/L as Fe	01046	
			X						X			Lead, Dissolved	UG/L as Pb	01049	
												Lindane, Total	UG/L	39782	
												Manganese, Dissolved	UG/L	01056	
			X									Mercury, Dissolved	UG/L	71890	

29 42 55 68 — 33 34 46 47 59 60 72 73 — 40 41 53 54 66 67 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-016
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical - Carteret, NJ
S.W. ID NO.: MW-3

LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	N.J. LAB CERT. NO.	WQM USE
T	NJ 0026077	26-08554-2	890207	73460	
1	2 – 8	9 – 16	17 – 22	23 – 27	28

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Acrylonitrile	UG/L	34215	25	K
												Benzene	UG/L	34030	15	
												Bromoform	UG/L	32104	1	K
												Carbon Tetrachloride	UG/L	32102	1	K
												Chlorobenzene	UG/L	34301	4.2	
												Chlorodibromoethane	UG/L	34306	1	K
												Chloroform	UG/L	32106	1	K
												1, 1 - Dichloroethane	UG/L	34496	1	K
												1, 2 - Dichloroethane	UG/L	34531	1	K
												1, 1 - Dichloroethylene	UG/L	34501	1	K
												1, 2 - Dichloropropane	UG/L	34541	1	K
												Ethylbenzene	UG/L	34371	1	K
												Methylene Chloride	UG/L	34423	380	
												1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	1	K
												Tetrachloroethylene	UG/L	34475	20	
												Toluene	UG/L	34012	12	
												1, 1, 1 - Trichloroethane	UG/L	34506	1	K
												1, 1, 2 - Trichloroethane	UG/L	34511	1	K
												Trichloroethylene	UG/L	39180	1	K
												Vinyl Chloride	UG/L	39175	1	K
												Acrolein	UG/L	34210	25	K
												Chloroethane	UG/L	34311	90	
												2 - Chloroethylvinyl Ether	UG/L	34576	1	K
												Dichlorobromomethane	UG/L	32105	1	K
												1, 3 - Dichloropropylene	UG/L	34699	1	K
												Methyl Bromide	UG/L	34413	1	K
												Methyl Chloride	UG/L	34418	1	K
												1, 2 - trans - Dichloroethylene	UG/L	34546	1	K
												1, 2 Dichlorobenzene	UG/L	34536	1	K
												1, 3 Dichlorobenzene	UG/L	34566	1	K
												1, 4 Dichlorobenzene	UG/L	34571	1	K

29 42 55 68 — 33 34 46 47 59 60 72 73 — 40 41 53 54 66 67 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ
SW ID NO.: MW-3
LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077	26-08554-2	890207	73460	
1	2 – 8	9 – 16	17 – 22	23 – 27	28

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Methoxychlor, Total	UG/L	39480		
												Methylene Blue Active Substances	MG/L	38260		
												Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
												Nitrogen, Nitrate, Dissolved	MG/L as N	00618		
												Odor	T.O.N.	00085		
			X									pH	Standard Units	00400	7.39	
												Phenols, Total Recoverable	UG/L	32730		
												Radium 226, Dissolved	Pc/L	09503		
												Radium 228, Dissolved	Pc/L	81366		
												Selenium, Dissolved	UG/L	01145		
												Silver, Dissolved	UG/L	01075		
												Sodium, Dissolved	MG/L	00930		
			X									Sulfate, Dissolved (as SO_4)	MG/L	00946		
X			X			X			X			Total Dissolved Solids (TDS)	PPM	70300	545	
												Total Organic Carbon (TOC)	PPM	00680		
												Total Organic Halogen (TOX)	UG/L	70353		
												Toxaphene	UG/L	39400		
												Turbidity	NTU	00076		
			X									Zinc, Dissolved	UG/L	01090		
												2, 4—D, Total	UG/L	39370		
												2, 4, 5—TP, Total	UG/L	39045		

29 33 34 40 41
42 46 47 53 54
55 59 60 66 67
68 72 73 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-015 A
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ
SW ID NO: MW-3
LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0027677	26-08554-2	890207	73460	
1	2 – 8	9 – 16	17 – 22	23 – 27	28

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		8.87	
X			X			X			X			Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		9.31	
X			X			X			X			Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	3.00	
X			X			X			X			Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	3.44	
			X									Arsenic, Dissolved	UG/L as As	01000		
												Barium, Dissolved	UG/L as Ba	01005		
												Biochemical Oxygen Demand - 5 Day	MG/L	00310		
												Cadmium, Dissolved	UG/L as Cd	01025		
X			X			X			X			Chloride, Dissolved	UG/L as Cl	82295	97900	
												Chromium, Dissolved	UG/L as Cr	01030		
												Chromium, Dissolved, Hexavalent	UG/L as Cr	01220		
												Chemical Oxygen Demand (COD), Dissolved	MG/L	00341		
												Coliform Group	N/100 ML	74056		
												Color	Pt - Co	00080		
												Copper, Dissolved	UG/L as Cu	01040		
												Cyanide, Total	MG/L as CN	00720		
												Endrin, Total	UG/L	39390		
												Fluoride, Dissolved	MG/L as F	00950		
												Gross Alpha, Dissolved	Pc/L	01503		
												Gross Beta, Dissolved	Pc/L	03503		
												Hardness, Total as $CaCO_3$	MG/L	00900		
												Iron, Dissolved	UG/L as Fe	01046		
			X						X			Lead, Dissolved	UG/L as Pb	01049		
												Lindane, Total	UG/L	39782		
												Manganese, Dissolved	UG/L	01056		
			X									Mercury, Dissolved	UG/L	71890		

29–33, 34–40, 41 / 42–46, 47–53, 54 / 55–59, 60–66, 67 / 68–72, 73–79, 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month

Year

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

5/83

DIVISION OF WATER RESOURCES

MONITORING REPORT — TRANSMITTAL SHEET

NJPDES NO. 0 0 2 6 0 7 7

REPORTING PERIOD: MO. YR. 1 1 88 THRU MO. YR. 0 1 89

PERMITTEE:

Name Unocal Chemical

Address 1345 North Meacham Road

Schaumburg, IL 60196

FACILITY:

Name Unocal Chemicals Division

Address 350 Roosevelt Avenue

Carteret (County) Middlesex

Telephone (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY

[ ] T-VWX-007 [ ] T-VWX-008 [ ] T-VWX-009

SLUDGE REPORTS - INDUSTRIAL

[ ] T-VWX-010A [ ] T-VWX-010B

WASTEWATER REPORTS

[ ] T-VWX-011 [ ] T-VWX-012 [ ] T-VWX-013

GROUNDWATER REPORTS

[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT

[ ] EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	[ ]	[X]
TEMPORARY BYPASSING	[ ]	[X]
DISINFECTION INTERRUPTION	[ ]	[X]
MONITORING MALFUNCTIONS	[ ]	[X]
UNITS OUT OF OPERATION	[ ]	[X]
OTHER	[ ]	[X]

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inq of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are signific penalties for submitting false information including the possibility of fine and imprisonr

LICENSED OPERATOR

Name *(Printed)* ______

Grade & Registry No. ______

Signature ______

Date ______

PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE

Name *(Printed)* Daryl W. Dierwechter

Title *(Printed)* Supervisor Environmental Affairs

Signature Daryl W. Dierwechter

Date March 21, 1989

Form VWX 017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ   SW ID NO: MW-2

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	26-08553-4	89 02 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	umhos/cm		14450	
X			X			X			X			Floating Product	inches		0	
X			X			X			X			Total Xylenes	ug/l		1.2	

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83 P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ	SW ID NO. MW-2
LAB NAME: NANCO Laboratories - Wappingers Falls, NY	

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08553-4	89 02 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 01 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

J	F	M	A	M	J	J	A	S	O	N	D	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
			X						X			Chrysene	ug/l	34320		
												Dibenzanthracene	ug/l	34556		
												1,2-Dichlorobenzene	ug/l	34536		
												1,3-Dichlorobenzene	ug/l	34566		
												1,4-Dichlorobenzene	ug/l	34571		
												3,3'-Dichlorobenzidine	ug/l	34631		
												Diethyl Phthalate	ug/l	34336		
												Dimethyl Phthalate	ug/l	34341		
												Di-n-butyl Phthalate	ug/l	39110		
												2,4-Dinitrotolulene	ug/l	34611		
												2,6-Dinitrotolulene	ug/l	34626		
												Di-n-octyl Phthalate	ug/l	34596		
												1,2-Diphenylhydrazine	ug/l	34346		
												Fluoranthene	ug/l	34376		
												Fluorene	ug/l	34381		
												Hexachlorobenzene	ug/l	39700		
												Hexachlorobutadiene	ug/l	34391		
												Hexachlorocyclopentadiene	ug/l	34386		
												Hexachloroethane	ug/l	34396		
												Indenopyrene	ug/l	34403		
												Isophorone	ug/l	34408		
												Naphthalene	ug/l	34696		
												Nitrobenzene	ug/l	34447		
												N-Nitrosodimethylamine	ug/l	34438		
												N-Nitrosodi-n-propylamine	ug/l	34428		
												N-Nitrosodiphenylamine	ug/l	34433		
												Phenanthrene	ug/l	34461		
												Pyrene	ug/l	34469		
												1,2,4-Trichlorobenzene	ug/l	34551		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
1/83

P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical - Carteret, NJ

SW ID NO.: MW-2

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

U

NJPDES NO.: NJ 0026077

WELL PERMIT NO.: 26-08553-4

SAMPLE DATE (YR. | MO. | DAY): 89 02 07

NJ LAB CERT. NO.: 73460

WCM USE:

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 90 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	ANALYSES	UNITS	PARAMETER	VALUE	REMARKS
			X						X			2-Chlorophenol	ug/1	34586		
												2,4-Dichlorophenol	ug/1	34601		
												2,4-Dimethylphenol	ug/1	34606		
												2,6-Dinitro-o-cresol	ug/1	77603		
												2,4-Dinitrophenol	ug/1	34616		
												2-Nitrophenol	ug/1	34591		
												4-Nitrophenol	ug/1	34649		
												p-Chloro-m-cresol	ug/1	34452		
												Pentachlorophenol	ug/1	39032		
												Phenol	ug/1	34695		
												2,4,6-Trichlorophenol	ug/1	34621		
												Acenaphthene	ug/1	34205		
												Acenaphthylene	ug/1	34200		
												Anthracene	ug/1	34220		
												Benzidine	ug/1	39120		
												Benzanthracene	ug/1	34526		
												Benzopyrene	ug/1	34247		
												3,4-Benzofluoranthene	ug/1	34230		
												Benzoperylene	ug/1	34521		
												Benzofluoranthene	ug/1	34242		
												Bis(2-chloroethoxy)methane	ug/1	34278		
												Bis(2-chloroethyl) Ether	ug/1	34273		
												Bis(2-chlroisopropyl) Ether	ug/1	34283		
												Bis(2-ethylhexyl) Phthalate	ug/1	39100		
												4-Bromophenyl Ether	ug/1	34636		
												Butylbenzyl Phthalate	ug/1	34292		
												2-Chloronaphthalene	ug/1	34581		
												4-Chlorophenyl Phenyl Ether	ug/1	34641		

VALUE CODING RULES AND

Form VWX-016
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical _ Carteret, NJ | SW ID NO.: MW-2

LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
T	NJ 0026077	26-08553-4	89 02 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Acrylonitrile	UG/L	34215	25	K
												Benzene	UG/L	34030	14	
												Bromoform	UG/L	32104	1	K
												Carbon Tetrachloride	UG/L	32102	1	K
												Chlorobenzene	UG/L	34301	6.2	
												Chlorodibromoethane	UG/L	34306	1	K
												Chloroform	UG/L	32106	1	K
												1, 1 - Dichloroethane	UG/L	34496	19	
												1, 2 - Dichloroethane	UG/L	34531	1	K
												1, 1 - Dichloroethylene	UG/L	34501	6.8	
												1, 2 - Dichloropropane	UG/L	34541	1	K
												Ethylbenzene	UG/L	34371	59	
												Methylene Chloride	UG/L	34423	2.6	
												1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	1	K
												Tetrachloroethylene	UG/L	34475	20	
												Toluene	UG/L	34012	1.3	
												1, 1, 1 - Trichloroethane	UG/L	34506	1	K
												1, 1, 2 - Trichloroethane	UG/L	34511	1	K
												Trichloroethylene	UG/L	39180	37	
												Vinyl Chloride	UG/L	39175	1	K
												Acrolein	UG/L	34210	25	K
												Chloroethane	UG/L	34311	1	K
												2 - Chloroethylvinyl Ether	UG/L	34576	1	K
												Dichlorobromomethane	UG/L	32105	1	K
												1, 3 - Dichloropropylene	UG/L	34699	7.3	
												Methyl Bromide	UG/L	34413	1	K
												Methyl Chloride	UG/L	34418	1	K
												1, 2 - trans - Dichloroethylene	UG/L	34546	1	K
												1, 2 Dichlorobenzene	UG/L	34536	1	K
												1, 3 Dichlorobenzene	UG/L	34566	1	K
												1, 4 Dichlorobenzene	UG/L	34571	1	K

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-015 B
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-2

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077	26-08553-4	890201	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Methoxychlor, Total	UG/L	39480		
												Methylene Blue Active Substances	MG/L	38260		
												Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
												Nitrogen, Nitrate Dissolved	MG/L as N	00618		
												Odor	T.O.N.	00095		
			X									pH	Standard Units	00400	7.03	
												Phenols, Total Recoverable	UG/L	32730		
												Radium 226, Dissolved	Pc/L	09503		
												Radium 228, Dissolved	Pc/L	81366		
												Selenium, Dissolved	UG/L	01145		
												Silver, Dissolved	UG/L	01075		
												Sodium, Dissolved	MG/L	00930		
			X									Sulfate, Dissolved (as SO_4)	MG/L	00946		
X			X			X			X			Total Dissolved Solids (TDS)	PPM	70300	9186	
												Total Organic Carbon (TOC)	PPM	00680		
												Total Organic Halogen (TOX)	UG/L	70353		
												Toxaphene	UG/L	39400		
												Turbidity	NTU	00076		
			X									Zinc, Dissolved	UG/L	01090		
												2, 4—D, Total	UG/L	39370		
												2, 4, 5—TP, Total	UG/L	39045		

29 33 34 40 41
42 46 47 53 54
55 59 60 66 67
68 72 73 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-015 A
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ — SW ID NO: MW-2

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE (YR. / MO. / DAY)	NJ LAB CERT. NO.	WQM USE
R	NJ 0026077	26 08553 - 4	89 02 07	73460	
1	2 – 8	9 – 16	17 – 22	23 – 27	28

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0 1 8 8 1 8 (MO. YR.) TO 0 1 8 9 2 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS (Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.)	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X Jan., X Apr., X July, X Oct.	Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		7.91	
X Jan., X Apr., X July, X Oct.	Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		8.47	
X Jan., X Apr., X July, X Oct.	Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	10.13	
X Jan., X Apr., X July, X Oct.	Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	10.69	
X Apr.	Arsenic, Dissolved	UG/L as As	01000		
	Barium, Dissolved	UG/L as Ba	01005		
	Biochemical Oxygen Demand - 5 Day	MG/L	00310		
	Cadmium, Dissolved	UG/L as Cd	01025		
X Jan., X Apr., X July, X Oct.	Chloride, Dissolved	UG/L as Cl	82295	5030900	
	Chromium, Dissolved	UG/L as Cr	01030		
	Chromium, Dissolved, Hexavalent	UG/L as Cr	01220		
	Chemical Oxygen Demand (COD), Dissolved	MG/L	00341		
	Coliform Group	N/100 ML	74056		
	Color	Pt - Co	00080		
	Copper, Dissolved	UG/L as Cu	01040		
	Cyanide, Total	MG/L as CN	00720		
	Endrin, Total	UG/L	39390		
	Fluoride, Dissolved	MG/L as F	00950		
	Gross Alpha, Dissolved	Pc/L	01503		
	Gross Beta, Dissolved	Pc/L	03503		
	Hardness, Total as $CaCO_3$	MG/L	00900		
	Iron, Dissolved	UG/L as Fe	01046		
X Apr., X Oct.	Lead, Dissolved	UG/L as Pb	01049		
	Lindane, Total	UG/L	39782		
	Manganese, Dissolved	UG/L	01055		
X Apr.	Mercury, Dissolved	UG/L	71890		

Parameter columns: 29–33, 42–46, 55–59, 68–72; value columns: 34–40, 47–53, 60–66, 73–79

VALUE CODING RULES AND
REMARK CODES ON REVERSE

5/83

DIVISION OF WATER RESOURCES

MONITORING REPORT — TRANSMITTAL SHEET

NJPDES NO. 0012600717

REPORTING PERIOD MO. YR. 11 88 THRU MO. YR. 01 89

PERMITTEE:

Name Unocal Chemical

Address 1345 North Meacham Road

Schaumburg, IL 60196

FACILITY:

Name Unocal Chemicals Division

Address 350 Roosevelt Avenue

Carteret (County) Middlesex

Telephone (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY

[ ] T-VWX-007 [ ] T-VWX-008 [ ] T-VWX-009

SLUDGE REPORTS - INDUSTRIAL

[ ] T-VWX-010A [ ] T-VWX-010B

WASTEWATER REPORTS

[ ] T-VWX-011 [ ] T-VWX-012 [ ] T-VWX-013

GROUNDWATER REPORTS

[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT

[ ] EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	[ ]	[X]
TEMPORARY BYPASSING	[ ]	[X]
DISINFECTION INTERRUPTION	[ ]	[X]
MONITORING MALFUNCTIONS	[ ]	[X]
UNITS OUT OF OPERATION	[ ]	[X]
OTHER	[ ]	[X]

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inqu of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significa penalties for submitting false information including the possibility of fine and imprisonm

LICENSED OPERATOR

Name *(Printed)* ________

Grade & Registry No. ________

Signature ________

Date ________

PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE

Name *(Printed)* Daryl W. Dierwechter

Title *(Printed)* Supervisor Environmental Affairs

Signature Daryl W. Dierwechter

Date March 21, 1989

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME	SW ID NO
Unocal Chemicals - Carteret, NJ	MW-3
LAB NAME	
NANCO Laboratories - Wappingers Falls, NY	

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08554-2	890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	umhos/cm		785	
X			X			X			X			Floating Product	inches	Trace	(less than 1/8")	
X			X			X			X			Total Xylenes	ug/l		2.4	

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83
P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECT
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ
SW ID NO.: MW-3
LAB NAME: NANCO Laboratories - Wappingers Falls, NY

U | NJPDES NO.: NJ 0026077 | WELL PERMIT NO.: 26-08554-2 | SAMPLE DATE YR. MO. DAY: 890207 | NJ LAB CERT. NO.: 73460 | WQM USE

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
			X						X			Chrysene	ug/1	34320		
												Dibenzanthracene	ug/1	34556		
												1,2-Dichlorobenzene	ug/1	34536		
												1,3-Dichlorobenzene	ug/1	34566		
												1,4-Dichlorobenzene	ug/1	34571		
												3,3'-Dichlorobenzidine	ug/1	34631		
												Diethyl Phthalate	ug/1	34336		
												Dimethyl Phthalate	ug/1	34341		
												Di-n-butyl Phthalate	ug/1	39110		
												2,4-Dinitrotolulene	ug/1	34611		
												2,6-Dinitrotolulene	ug/1	34626		
												Di-n-octyl Phthalate	ug/1	34596		
												1,2-Diphenylhydrazine	ug/1	34346		
												Fluoranthene	ug/1	34376		
												Fluorene	ug/1	34381		
												Hexachlorobenzene	ug/1	39700		
												Hexachlorobutadiene	ug/1	34391		
												Hexachlorocyclopentadiene	ug/1	34386		
												Hexachloroethane	ug/1	34396		
												Indenopyrene	ug/1	34403		
												Isophorone	ug/1	34408		
												Naphthalene	ug/1	34696		
												Nitrobenzene	ug/1	34447		
												N-Nitrosodimethylamine	ug/1	34438		
												N-Nitrosodi-n-propylamine	ug/1	34428		
												N-Nitrosodiphenylamine	ug/1	34433		
												Phenanthrene	ug/1	34461		
												Pyrene	ug/1	34469		
												1,2,4-Trichlorobenzene	ug/1	34551		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT
ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical - Carteret, NJ	SW ID NO. MW-3
LAB NAME: NANCO Laboratories - Wappingers Falls, NY	

U

NJPDES NO. NJ 0026077 | WELL PERMIT NO. 26-08554-2 | SAMPLE DATE YR. / MO. / DAY 89 02 07 | NJ LAB CERT. NO. 73460 | WCM USE

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANALYTES	UNITS	PARAMETER	VALUE	REMARKS
			X						X			2-Chlorophenol	ug/1	34586		
												2,4-Dichlorophenol	ug/1	34601		
												2,4-Dimethylphenol	ug/1	34606		
												2,6-Dinitro-o-cresol	ug/1	77603		
												2,4-Dinitrophenol	ug/1	34616		
												2-Nitrophenol	ug/1	34591		
												4-Nitrophenol	ug/1	34649		
												p-Chloro-m-cresol	ug/1	34452		
												Pentachlorophenol	ug/1	39032		
												Phenol	ug/1	34695		
												2,4,6-Trichlorophenol	ug/1	34621		
												Acenaphthene	ug/1	34205		
												Acenaphthylene	ug/1	34200		
												Anthracene	ug/1	34220		
												Benzidine	ug/1	39120		
												Benzanthracene	ug/1	34526		
												Benzopyrene	ug/1	34247		
												3,4-Benzofluoranthene	ug/1	34230		
												Benzoperylene	ug/1	34521		
												Benzofluoranthene	ug/1	34242		
												Bis(2-chloroethoxy)methane	ug/1	34278		
												Bis(2-chloroethyl) Ether	ug/1	34273		
												Bis(2-chlroisopropyl) Ether	ug/1	34283		
												Bis(2-ethylhexyl) Phthalate	ug/1	39100		
												4-Bromophenyl Ether	ug/1	34636		
												Butylbenzyl Phthalate	ug/1	34292		
												2-Chloronaphthalene	ug/1	34581		
												4-Chlorophenyl Phenyl Ether	ug/1	34641		

VALUE CODING RULES AND

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month [|] Year [|]

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ — SW ID NO. MW-4

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077	26-08555-1	89 02 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
	Methoxychlor, Total	UG/L	39480		
	Methylene Blue Active Substances	MG/L	38260		
	Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
	Nitrogen, Nitrate, Dissolved	MG/L as N	00618		
	Odor	T.O.N.	00085		
Apr.	pH	Standard Units	00400	7.06	
	Phenols, Total Recoverable	UG/L	32730		
	Radium 226, Dissolved	Pc/L	09503		
	Radium 228, Dissolved	Pc/L	81366		
	Selenium, Dissolved	UG/L	01145		
	Silver, Dissolved	UG/L	01075		
	Sodium, Dissolved	MG/L	00930		
Apr.	Sulfate, Dissolved (as SO_4)	MG/L	00946		
Jan., Apr., July, Oct.	Total Dissolved Solids (TDS)	PPM	70300	483	
	Total Organic Carbon (TOC)	PPM	00680		
	Total Organic Halogen (TOX)	UG/L	70353		
	Toxaphene	UG/L	39400		
	Turbidity	NTU	00076		
Apr.	Zinc, Dissolved	UG/L	01090		
	2, 4–D, Total	UG/L	39370		
	2, 4, 5–TP, Total	UG/L	39045		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-015 A
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ
SW ID NO: MW-4
LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0 0 2 6 0 7 7	2 6 - 0 8 5 5 5 - 1	8 9 0 2 0 7	7 3 4 6 0	
1	2 … 8	9 … 16	17 … 22	23 … 27	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0 8 8 8 (MO. YR.) TO 0 8 9 2 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		8.68	
X			X			X			X			Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		9.30	
X			X			X			X			Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	2.67	
X			X			X			X			Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	3.29	
			X									Arsenic, Dissolved	UG/L as As	01000		
												Barium, Dissolved	UG/L as Ba	01005		
												Biochemical Oxygen Demand - 5 Day	MG/L	00310		
												Cadmium, Dissolved	UG/L as Cd	01025		
X			X			X			X			Chloride, Dissolved	UG/L as Cl	82295	48900	
												Chromium, Dissolved	UG/L as Cr	01030		
												Chromium, Dissolved, Hexavalent	UG/L as Cr	01220		
												Chemical Oxygen Demand (COD), Dissolved	MG/L	00341		
												Coliform Group	N/100 ML	74056		
												Color	Pt - Co	00080		
												Copper, Dissolved	UG/L as Cu	01040		
												Cyanide, Total	MG/L as CN	00720		
												Endrin, Total	UG/L	39390		
												Fluoride, Dissolved	MG/L as F	00950		
												Gross Alpha, Dissolved	Pc/L	01503		
												Gross Beta, Dissolved	Pc/L	03503		
												Hardness, Total as $CaCO_3$	MG/L	00900		
												Iron, Dissolved	UG/L as Fe	01046		
			X						X			Lead, Dissolved	UG/L as Pb	01049		
												Lindane, Total	UG/L	39782		
												Manganese, Dissolved	UG/L	01056		
			X									Mercury, Dissolved	UG/L	71890		

29 33 34 40 41
42 46 47 53 54
55 59 60 66 67
68 72 73 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-016
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical - Carteret, NJ — SW ID NO. MW-4

LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	LAB CERT. NO.	WQM USE
T	NJ 0026077	26-08555-1	89 02 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Acrylonitrile	UG/L	34215	25	K
												Benzene	UG/L	34030	2100	
												Bromoform	UG/L	32104	100	K
												Carbon Tetrachloride	UG/L	32102	100	K
												Chlorobenzene	UG/L	34301	4600	
												Chlorodibromoethane	UG/L	34306	100	K
												Chloroform	UG/L	32106	100	K
												1, 1 - Dichloroethane	UG/L	34496	100	K
												1, 2 - Dichloroethane	UG/L	34531	100	K
												1, 1 - Dichloroethylene	UG/L	34501	100	K
												1, 2 - Dichloropropane	UG/L	34541	100	K
												Ethylbenzene	UG/L	34371	100	K
												Methylene Chloride	UG/L	34423	290	
												1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	100	K
												Tetrachloroethylene	UG/L	34475	100	K
												Toluene	UG/L	34010	6800	
												1, 1, 1 - Trichloroethane	UG/L	34506	21	
												1, 1, 2 - Trichloroethane	UG/L	34511	100	K
												Trichloroethylene	UG/L	39180	100	K
												Vinyl Chloride	UG/L	39175	100	K
												Acrolein	UG/L	34210	25	K
												Chloroethane	UG/L	34311	89	
												2 - Chloroethylvinyl Ether	UG/L	34576	100	K
												Dichlorobromomethane	UG/L	32101	100	K
												1, 3 - Dichloropropylene	UG/L	34699	100	K
												Methyl Bromide	UG/L	34413	100	K
												Methyl Chloride	UG/L	34418	100	K
												1, 2 - trans - Dichloroethylene	UG/L	34546	100	K
												1, 2 Dichlorobenzene	UG/L	34536	100	K
												1, 3 Dichlorobenzene	UG/L	34566	100	K
												1, 4 Dichlorobenzene	UG/L	34571	100	K

VALUE CODING RULES AND
REMARK CODES ON REVERSE

MONITORING REPORT — TRANSMITTAL SHEET

NPDES NO.	REPORTING PERIOD MO. YR.		MO. YR.
0 0 2 6 0 7 7	1 1 8 8	THRU	0 1 8 9

PERMITTEE: Name Unocal Chemical

Address 1345 North Meacham Road

Schaumburg, IL 60196

FACILITY: Name Unocal Chemicals Division

Address 350 Roosevelt Avenue

Carteret (County) Middlesex

Telephone (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY

☐ T-VWX-007 ☐ T-VWX-008 ☐ T-VWX-009

SLUDGE REPORTS - INDUSTRIAL

☐ T-VWX-010A ☐ T-VWX-010B

WASTEWATER REPORTS

☐ T-VWX-011 ☐ T-VWX-012 ☐ T-VWX-013

GROUNDWATER REPORTS

[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT

☐ EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	☐	☒
TEMPORARY BYPASSING	☐	☒
DISINFECTION INTERRUPTION	☐	☒
MONITORING MALFUNCTIONS	☐	☒
UNITS OUT OF OPERATION	☐	☒
OTHER	☐	☒

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inqu of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significa penalties for submitting false information including the possibility of fine and imprisonm

LICENSED OPERATOR

Name (Printed) ______

Grade & Registry No. ______

Signature ______

Date ______

PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE

Name (Printed) Daryl W. Dierwechter

Title (Printed) Supervisor Environmental Affairs

Signature [signature]

Date March 21, 1989

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ
SW ID NO: MW-4
LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	26-08555-1	890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	umhos/cm		727	
X			X			X			X			Floating Product	inches		0	
X			X			X			X			Total Xylenes	ug/l		1100	

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83 P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT
ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ
SW ID NO.: MW-4
LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. MO. DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	26-08555-1	890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0188 (MO. YR.) TO 1292 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS: J F M A M J J A S O N D (X marked under A and O)

ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
Chrysene	ug/l	34320		
Dibenzanthracene	ug/l	34556		
1,2-Dichlorobenzene	ug/l	34536		
1,3-Dichlorobenzene	ug/l	34566		
1,4-Dichlorobenzene	ug/l	34571		
3,3'-Dichlorobenzidine	ug/l	34631		
Diethyl Phthalate	ug/l	34336		
Dimethyl Phthalate	ug/l	34341		
Di-n-butyl Phthalate	ug/l	39110		
2,4-Dinitrotolulene	ug/l	34611		
2,6-Dinitrotolulene	ug/l	34626		
Di-n-octyl Phthalate	ug/l	34596		
1,2-Diphenylhydrazine	ug/l	34346		
Fluoranthene	ug/l	34376		
Fluorene	ug/l	34381		
Hexachlorobenzene	ug/l	39700		
Hexachlorobutadiene	ug/l	34391		
Hexachlorocyclopentadiene	ug/l	34386		
Hexachloroethane	ug/l	34396		
Indenopyrene	ug/l	34403		
Isophorone	ug/l	34408		
Naphthalene	ug/l	34696		
Nitrobenzene	ug/l	34447		
N-Nitrosodimethylamine	ug/l	34438		
N-Nitrosodi-n-propylamine	ug/l	34428		
N-Nitrosodiphenylamine	ug/l	34433		
Phenanthrene	ug/l	34461		
Pyrene	ug/l	34469		
1,2,4-Trichlorobenzene	ug/l	34551		

VALUE CODING RULES AND REMARK CODES ON REVERSE

Form VWX-017
UEI

P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical - Carteret, NJ — SW ID NO. MW-4

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08555-1	89 / 02 / 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS J	F	M	A	M	J	J	A	S	O	N	D	ANALYSES	UNITS	PARAMETER	VALUE	REMARKS
			X						X			2-Chlorophenol	ug/1	34586		
												2,4-Dichlorophenol	ug/1	34601		
												2,4-Dimethylphenol	ug/1	34606		
												2,6-Dinitro-o-cresol	ug/1	77603		
												2,4-Dinitrophenol	ug/1	34616		
												2-Nitrophenol	ug/1	34591		
												4-Nitrophenol	ug/1	34649		
												p-Chloro-m-cresol	ug/1	34452		
												Pentachlorophenol	ug/1	39032		
												Phenol	ug/1	34695		
												2,4,6-Trichlorophenol	ug/1	34621		
												Acenaphthene	ug/1	34205		
												Acenaphthylene	ug/1	34200		
												Anthracene	ug/1	34220		
												Benzidine	ug/1	39120		
												Benzanthracene	ug/1	34526		
												Benzopyrene	ug/1	34247		
												3,4-Benzofluoranthene	ug/1	34230		
												Benzoperylene	ug/1	34521		
												Benzofluoranthene	ug/1	34242		
												Bis(2-chloroethoxy)methane	ug/1	34278		
												Bis(2-chloroethyl) Ether	ug/1	34273		
												Bis(2-chlroisopropyl) Ether	ug/1	34283		
												Bis(2-ethylhexyl) Phthalate	ug/1	39100		
												4-Bromophenyl Ether	ug/1	34636		
												Butylbenzyl Phthalate	ug/1	34292		
												2-Chloronaphthalene	ug/1	34581		
												4-Chlorophenyl Phenyl Ether	ug/1	34641		

VALUE CODING RULES AND

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month ___ Year ___

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

Form VWX-015 A
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ — SW ID NO: MW-6

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0 0 2 6 0 7 7	2 6 - 0 8 5 5 7 - 7	8 9 0 2 0 7	7 3 4 6 0	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0 8 8 8 (MO. YR.) TO 0 8 9 2 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE
X			X			X			X			Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		8.60
X			X			X			X			Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		8.84
X			X			X			X			Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	4.40
X			X			X			X			Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	4.64
			X									Arsenic, Dissolved	UG/L as As	01000	
												Barium, Dissolved	UG/L as Ba	01005	
												Biochemical Oxygen Demand - 5 Day	MG/L	00310	
												Cadmium, Dissolved	UG/L as Cd	01025	
X			X			X			X			Chloride, Dissolved	UG/L as Cl	82295	358100
												Chromium, Dissolved	UG/L as Cr	01030	
												Chromium, Dissolved, Hexavalent	UG/L as Cr	01220	
												Chemical Oxygen Demand (COD), Dissolved	MG/L	00341	
												Coliform Group	N/100 ML	74056	
												Color	Pt - Co	00080	
												Copper, Dissolved	UG/L as Cu	01040	
												Cyanide, Total	MG/L as CN	00720	
												Endrin, Total	UG/L	39390	
												Fluoride, Dissolved	MG/L as F	00950	
												Gross Alpha, Dissolved	Pc/L	01503	
												Gross Beta, Dissolved	Pc/L	03503	
												Hardness, Total as $CaCO_3$	MG/L	00900	
												Iron, Dissolved	UG/L as Fe	01046	
			X						X			Lead, Dissolved	UG/L as Pb	01049	
												Lindane, Total	UG/L	39782	
												Manganese, Dissolved	UG/L	01056	
			X									Mercury, Dissolved	UG/L	71890	

29 33 34 40 41
42 46 47 53 54
55 59 60 66 67
68 72 73 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-015 B
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ — SW ID NO.: MW-6

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077	26-08557-7	890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Methoxychlor, Total	UG/L	39480		
												Methylene Blue Active Substances	MG/L	38260		
												Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
												Nitrogen, Nitrate, Dissolved	MG/L as N	00618		
												Odor	T.O.N.	00085		
			X									pH	Standard Units	00400	6.36	
												Phenols, Total Recoverable	UG/L	32730		
												Radium 226, Dissolved	Pc/L	09503		
												Radium 228, Dissolved	Pc/L	81366		
												Selenium, Dissolved	UG/L	01145		
												Silver, Dissolved	UG/L	01075		
												Sodium, Dissolved	MG/L	00930		
			X									Sulfate, Dissolved (as SO_4)	MG/L	00946		
X			X			X			X			Total Dissolved Solids (TDS)	PPM	70300	889	
												Total Organic Carbon (TOC)	PPM	00680		
												Total Organic Halogen (TOX)	UG/L	70353		
												Toxaphene	UG/L	39400		
												Turbidity	NTU	00076		
			X									Zinc, Dissolved	UG/L	01090		
												2, 4–D, Total	UG/L	39370		
												2, 4, 5–TP, Total	UG/L	39045		

25 42 55 68 — 33 34 46 47 59 60 72 73 — 40 41 53 54 66 67 79 80

VALUE CODING RULES AND REMARK CODES ON REVERSE

Form VWX-016
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical - Carteret, NJ   SW ID NO: MW-6

LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. MO. DAY	NJ LAB CERT. NO.	WQM USE
T	NJ 0026077	26-08557-7	890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS: Jan., Apr., July, Oct. (marked X)

ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
Acrylonitrile	UG/L	34215	25	K
Benzene	UG/L	34030	100	K
Bromoform	UG/L	32104	100	K
Carbon Tetrachloride	UG/L	32102	100	K
Chlorobenzene	UG/L	34301	8000	
Chlorodibromoethane	UG/L	34306	100	K
Chloroform	UG/L	32106	100	K
1, 1 - Dichloroethane	UG/L	34496	100	K
1, 2 - Dichloroethane	UG/L	34531	100	K
1, 1 - Dichloroethylene	UG/L	34501	100	K
1, 2 - Dichloropropane	UG/L	34541	100	K
Ethylbenzene	UG/L	34371	100	K
Methylene Chloride	UG/L	34423	1100	
1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	100	K
Tetrachloroethylene	UG/L	34475	100	K
Toluene	UG/L	34012	10.0	K
1, 1, 1 - Trichloroethane	UG/L	34506	3200	
1, 1, 2 - Trichloroethane	UG/L	34511	100	K
Trichloroethylene	UG/L	39180	100	K
Vinyl Chloride	UG/L	39175	100	K
Acrolein	UG/L	34210	25	K
Chloroethane	UG/L	34311	100	K
2 - Chloroethylvinyl Ether	UG/L	34576	100	K
Dichlorobromomethane	UG/L	32101	100	K
1, 3 - Dichloropropylene	UG/L	34699	100	K
Methyl Bromide	UG/L	34413	100	K
Methyl Chloride	UG/L	34418	100	K
1, 2 - trans - Dichloroethylene	UG/L	34546	100	K
1, 2 Dichlorobenzene	UG/L	34536	100	K
1, 3 Dichlorobenzene	UG/L	34566	100	K
1, 4 Dichlorobenzene	UG/L	34571	25000	C

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT
ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME	Unocal Chemical - Carteret, NJ
SW ID NO.	MW-6
LAB NAME	NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. MO. DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	26-08557-7	89 02 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS: boxes 4 and 10 marked (X)

ANALYSES	UNITS	PARAMETER	VALUE	REMARKS
2-Chlorophenol	ug/l	34586		
2,4-Dichlorophenol	ug/l	34601		
2,4-Dimethylphenol	ug/l	34606		
2,6-Dinitro-o-cresol	ug/l	77603		
2,4-Dinitrophenol	ug/l	34616		
2-Nitrophenol	ug/l	34591		
4-Nitrophenol	ug/l	34649		
p-Chloro-m-cresol	ug/l	34452		
Pentachlorophenol	ug/l	39032		
Phenol	ug/l	34695		
2,4,6-Trichlorophenol	ug/l	34621		
Acenaphthene	ug/l	34205		
Acenaphthylene	ug/l	34200		
Anthracene	ug/l	34220		
Benzidine	ug/l	39120		
Benzanthracene	ug/l	34526		
Benzopyrene	ug/l	34247		
3,4-Benzofluoranthene	ug/l	34230		
Benzoperylene	ug/l	34521		
Benzofluoranthene	ug/l	34242		
Bis(2-chloroethoxy)methane	ug/l	34278		
Bis(2-chloroethyl) Ether	ug/l	34273		
Bis(2-chlroisopropyl) Ether	ug/l	34283		
Bis(2-ethylhexyl) Phthalate	ug/l	39100		
4-Bromophenyl Ether	ug/l	34636		
Butylbenzyl Phthalate	ug/l	34292		
2-Chloronaphthalene	ug/l	34581		
4-Chlorophenyl Phenyl Ether	ug/l	34641		

29 33 34 40 41
42 46 47 53 54
55 59 60 66 67
73 80

VALUE CODING RULES AND

Form VWX-017
4/83

P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECT
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-6

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	26-08557-7	890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

J	F	M	A	M	J	J	A	S	O	N	D	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
			X						X			Chrysene	ug/l	34320		
												Dibenzanthracene	ug/l	34556		
												1,2-Dichlorobenzene	ug/l	34536		
												1,3-Dichlorobenzene	ug/l	34566		
												1,4-Dichlorobenzene	ug/l	34571		
												3,3'-Dichlorobenzidine	ug/l	34631		
												Diethyl Phthalate	ug/l	34336		
												Dimethyl Phthalate	ug/l	34341		
												Di-n-butyl Phthalate	ug/l	39110		
												2,4-Dinitrotolulene	ug/l	34611		
												2,6-Dinitrotolulene	ug/l	34626		
												Di-n-octyl Phthalate	ug/l	34596		
												1,2-Diphenylhydrazine	ug/l	34346		
												Fluoranthene	ug/l	34376		
												Fluorene	ug/l	34381		
												Hexachlorobenzene	ug/l	39700		
												Hexachlorobutadiene	ug/l	34391		
												Hexachlorocyclopentadiene	ug/l	34386		
												Hexachloroethane	ug/l	34396		
												Indenopyrene	ug/l	34403		
												Isophorone	ug/l	34408		
												Naphthalene	ug/l	34696		
												Nitrobenzene	ug/l	34447		
												N-Nitrosodimethylamine	ug/l	34438		
												N-Nitrosodi-n-propylamine	ug/l	34428		
												N-Nitrosodiphenylamine	ug/l	34433		
												Phenanthrene	ug/l	34461		
												Pyrene	ug/l	34469		
												1,2,4-Trichlorobenzene	ug/l	34551		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ — SW ID NO: MW-6

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08557-7	890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	umhos/cm		1505	
X			X			X			X			Floating Product	inches		0	
X			X			X			X			Total Xylenes	ug/l		930	

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-015 A
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ
SW ID NO: MW-7
LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0026077	26-08558-5	890207	73460	
1	2–8	9–16	17–22	23–27	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		8.24	
X			X			X			X			Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		8.83	
X			X			X			X			Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	4.74	
X			X			X			X			Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	5.33	
			X									Arsenic, Dissolved	UG/L as As	01000		
												Barium, Dissolved	UG/L as Ba	01005		
												Biochemical Oxygen Demand - 5 Day	MG/L	00310		
												Cadmium, Dissolved	UG/L as Cd	01025		
X			X			X			X			Chloride, Dissolved	UG/L as Cl	82295	290900	
												Chromium, Dissolved	UG/L as Cr	01030		
												Chromium, Dissolved, Hexavalent	UG/L as Cr	01220		
												Chemical Oxygen Demand (COD), Dissolved	MG/L	00341		
												Coliform Group	N/100 ML	74056		
												Color	Pt - Co	00080		
												Copper, Dissolved	UG/L as Cu	01040		
												Cyanide, Total	MG/L as CN	00720		
												Endrin, Total	UG/L	39390		
												Fluoride, Dissolved	MG/L as F	00950		
												Gross Alpha, Dissolved	Pc/L	01503		
												Gross Beta, Dissolved	Pc/L	03503		
												Hardness, Total as $CaCO_3$	MG/L	00900		
												Iron, Dissolved	UG/L as Fe	01046		
			X						X			Lead, Dissolved	UG/L as Pb	01049		
												Lindane, Total	UG/L	39782		
												Manganese, Dissolved	UG/L	01056		
			X									Mercury, Dissolved	UG/L	71890		

29 33 34 40 41
42 46 47 53 54
55 59 60 66 67
68 72 73 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

DIVISION OF WATER RESOURCES

WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-7

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077	26-08558-5	890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Methoxychlor, Total	UG/L	39480		
												Methylene Blue Active Substances	MG/L	38260		
												Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
												Nitrogen, Nitrate Dissolved	MG/L as N	00618		
												Odor	T.O.N.	00085		
			X									pH	Standard Units	00400	7.05	
												Phenols, Total Recoverable	UG/L	32730		
												Radium 226, Dissolved	Pc/L	09503		
												Radium 228, Dissolved	Pc/L	81366		
												Selenium, Dissolved	UG/L	01145		
												Silver, Dissolved	UG/L	01075		
												Sodium, Dissolved	MG/L	00930		
			X									Sulfate, Dissolved (as SO_4)	MG/L	00946		
X			X			X			X			Total Dissolved Solids (TDS)	PPM	70300	939	
												Total Organic Carbon (TOC)	PPM	00680		
												Total Organic Halogen (TOX)	UG/L	70353		
												Toxaphene	UG/L	39400		
												Turbidity	NTU	00076		
			X									Zinc, Dissolved	UG/L	01090		
												2, 4—D, Total	UG/L	39370		
												2, 4, 5—TP, Total	UG/L	39045		

VALUE CODING RULES AND REMARK CODES ON REVERSE

Form VWX-016
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical - Carteret, NJ
S.W. ID NO.: MW-7

LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. MO. DAY	LAB CERT. NO.	WQM USE
T	NJ 0026077	26-08558-5	890207	73460	
1	2 – 8	9 – 16	17 – 22	23 – 27	28

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Acrylonitrile	UG/L	34215	500	K
												Benzene	UG/L	34030	1200	
												Bromoform	UG/L	32104	200	K
												Carbon Tetrachloride	UG/L	32102	200	K
												Chlorobenzene	UG/L	34301	50	
												Chlorodibromoethane	UG/L	34306	200	K
												Chloroform	UG/L	32106	200	K
												1, 1 - Dichloroethane	UG/L	34496	4800	
												1, 2 - Dichloroethane	UG/L	34531	13000	
												1, 1 - Dichloroethylene	UG/L	34501	29000	
												1, 2 - Dichloropropane	UG/L	34541	200	K
												Ethylbenzene	UG/L	34371	200	K
												Methylene Chloride	UG/L	34423	48	
												1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	200	K
												Tetrachloroethylene	UG/L	34475	200	K
												Toluene	UG/L	34012	4500	
												1, 1, 1 - Trichloroethane	UG/L	34506	271000	C
												1, 1, 2 - Trichloroethane	UG/L	34511	200	K
												Trichloroethylene	UG/L	39180	200	K
												Vinyl Chloride	UG/L	39175	200	K
												Acrolein	UG/L	34210	500	
												Chloroethane	UG/L	34311	200	K
												2 - Chloroethylvinyl Ether	UG/L	34576	200	K
												Dichlorobromomethane	UG/L	32105	200	K
												1, 3 - Dichloropropylene	UG/L	34693	200	K
												Methyl Bromide	UG/L	34413	200	K
												Methyl Chloride	UG/L	34418	200	K
												1, 2 - trans - Dichloroethylene	UG/L	34546	200	K
												1, 2 Dichlorobenzene	UG/L	34536	200	K
												1, 3 Dichlorobenzene	UG/L	34566	200	K
												1, 4 Dichlorobenzene	UG/L	34571	200	K
														29 – 33 42 – 46 55 – 59 68 – 72	34 – 40 47 – 53 60 – 66 73 – 79	41 54 67 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
6/83

P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical - Carteret, NJ	SW ID NO. MW-7
LAB NAME: NANCO Laboratories - Wappingers Falls, NY	

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08558-5	89 / 02 / 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

J	F	M	A	M	J	J	A	S	O	N	D	ANALYSES	UNITS	PARAMETER	VALUE	REMARKS
			X						X			2-Chlorophenol	ug/1	34586		
												2,4-Dichlorophenol	ug/1	34601		
												2,4-Dimethylphenol	ug/1	34606		
												2,6-Dinitro-o-cresol	ug/1	77603		
												2,4-Dinitrophenol	ug/1	34616		
												2-Nitrophenol	ug/1	34591		
												4-Nitrophenol	ug/1	34649		
												p-Chloro-m-cresol	ug/1	34452		
												Pentachlorophenol	ug/1	39032		
												Phenol	ug/1	34695		
												2,4,6-Trichlorophenol	ug/1	34621		
												Acenaphthene	ug/1	34205		
												Acenaphthylene	ug/1	34200		
												Anthracene	ug/1	34220		
												Benzidine	ug/1	39120		
												Benzanthracene	ug/1	34526		
												Benzopyrene	ug/1	34247		
												3,4-Benzofluoranthene	ug/1	34230		
												Benzoperylene	ug/1	34521		
												Benzofluoranthene	ug/1	34242		
												Bis(2-chloroethoxy)methane	ug/1	34278		
												Bis(2-chloroethyl) Ether	ug/1	34273		
												Bis(2-chlroisopropyl) Ether	ug/1	34283		
												Bis(2-ethylhexyl) Phthalate	ug/1	39100		
												4-Bromophenyl Ether	ug/1	34636		
												Butylbenzyl Phthalate	ug/1	34292		
												2-Chloronaphthalene	ug/1	34581		
												4-Chlorophenyl Phenyl Ether	ug/1	34641		

VALUE CODING RULES AND

Form VWX-017
4/83
P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

GW ID NO.: MW-7

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08558-5	89 02 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

J	F	M	A	M	J	J	A	S	O	N	D	ANALYTES	UNITS	PARAMETER	VALUE	REMARKS
			X						X			Chrysene	ug/1	34320		
												Dibenzanthracene	ug/1	34556		
												1,2-Dichlorobenzene	ug/1	34536		
												1,3-Dichlorobenzene	ug/1	34566		
												1,4-Dichlorobenzene	ug/1	34571		
												3,3'-Dichlorobenzidine	ug/1	34631		
												Diethyl Phthalate	ug/1	34336		
												Dimethyl Phthalate	ug/1	34341		
												Di-n-butyl Phthalate	ug/1	39110		
												2,4-Dinitrotolulene	ug/1	34611		
												2,6-Dinitrotolulene	ug/1	34626		
												Di-n-octyl Phthalate	ug/1	34596		
												1,2-Diphenylhydrazine	ug/1	34346		
												Fluoranthene	ug/1	34376		
												Fluorene	ug/1	34381		
												Hexachlorobenzene	ug/1	39700		
												Hexachlorobutadiene	ug/1	34391		
												Hexachlorocyclopentadiene	ug/1	34386		
												Hexachloroethane	ug/1	34396		
												Indenopyrene	ug/1	34403		
												Isophorone	ug/1	34408		
												Naphthalene	ug/1	34696		
												Nitrobenzene	ug/1	34447		
												N-Nitrosodimethylamine	ug/1	34438		
												N-Nitrosodi-n-propylamine	ug/1	34428		
												N-Nitrosodiphenylamine	ug/1	34433		
												Phenanthrene	ug/1	34461		
												Pyrene	ug/1	34469		
												1,2,4-Trichlorobenzene	ug/1	34551		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ | SW ID NO: MW-7

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	26-08558-5	890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	umhos/cm		1331	
X			X			X			X			Floating Product	inches		0	
X			X			X			X			Total Xylenes	ug/l		200	K

VALUE CODING RULES AND
REMARK CODES ON REVERSE

MONITORING REPORT – TRANSMITTAL SHEET

NJPDES NO.	REPORTING PERIOD MO. YR.		MO. YR.
0 0 2 6 0 7 7	1 1 8 8	THRU	0 1 8 9

PERMITTEE:

Name: Unocal Chemical

Address: 1345 North Meacham Road

Schaumburg, IL 60196

FACILITY:

Name: Unocal Chemicals Division

Address: 350 Roosevelt Avenue

Carteret (County) Middlesex

Telephone (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY

[ ] T-VWX-007 [ ] T-VWX-008 [ ] T-VWX-009

SLUDGE REPORTS - INDUSTRIAL

[ ] T-VWX-010A [ ] T-VWX-010B

WASTEWATER REPORTS

[ ] T-VWX-011 [ ] T-VWX-012 [ ] T-VWX-013

GROUNDWATER REPORTS

[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT

[ ] EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	[ ]	[X]
TEMPORARY BYPASSING	[ ]	[X]
DISINFECTION INTERRUPTION	[ ]	[X]
MONITORING MALFUNCTIONS	[ ]	[X]
UNITS OUT OF OPERATION	[ ]	[X]
OTHER	[ ]	[X]

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inqu of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are signific penalties for submitting false information including the possibility of fine and imprisonm

LICENSED OPERATOR

Name *(Printed)* ______

Grade & Registry No. ______

Signature ______

Date ______

PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE

Name *(Printed)* Daryl W. Dierwechter

Title *(Printed)* Supervisor Environmental Affairs

Signature Daryl W. Dierwechter

Date March 21, 1989

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month ☐☐ Year ☐☐

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

Form VWX-015 A
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ — SW ID NO. MW-8

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0002607	26-08559-3	890207	73460	
1	2–8	9–16	17–22	23–27	28

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		8.82	
X			X			X			X			Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		9.43	
X			X			X			X			Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	4.50	
X			X			X			X			Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	5.11	
			X									Arsenic, Dissolved	UG/L as As	01000		
												Barium, Dissolved	UG/L as Ba	01005		
												Biochemical Oxygen Demand - 5 Day	MG/L	00310		
												Cadmium, Dissolved	UG/L as Cd	01025		
X			X			X			X			Chloride, Dissolved	UG/L as Cl	82295	181400	
												Chromium, Dissolved	UG/L as Cr	01030		
												Chromium, Dissolved, Hexavalent	UG/L as Cr	01220		
												Chemical Oxygen Demand (COD), Dissolved	MG/L	00341		
												Coliform Group	N/100 ML	74056		
												Color	Pt - Co	00080		
												Copper, Dissolved	UG/L as Cu	01040		
												Cyanide, Total	MG/L as CN	00720		
												Endrin, Total	UG/L	39390		
												Fluoride, Dissolved	MG/L as F	00950		
												Gross Alpha, Dissolved	Pc/L	01503		
												Gross Beta, Dissolved	Pc/L	03503		
												Hardness, Total as $CaCO_3$	MG/L	00900		
												Iron, Dissolved	UG/L as Fe	01046		
			X						X			Lead, Dissolved	UG/L as Pb	01049		
												Lindane, Total	UG/L	39782		
												Manganese, Dissolved	UG/L	01056		
			X									Mercury, Dissolved	UG/L	71890		

29 33 34 40 41
42 46 47 53 54
55 59 60 66 67
68 72 73 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-015 B
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-8

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077	26-08559-3	890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Methoxychlor, Total	UG/L	39480		
												Methylene Blue Active Substances	MG/L	38260		
												Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
												Nitrogen, Nitrate Dissolved	MG/L as N	00618		
												Odor	T.O.N.	00085		
			X									pH	Standard Units	00400	7.36	
												Phenols, Total Recoverable	UG/L	32730		
												Radium 226, Dissolved	Pc/L	09503		
												Radium 228, Dissolved	Pc/L	81366		
												Selenium, Dissolved	UG/L	01145		
												Silver, Dissolved	UG/L	01075		
												Sodium, Dissolved	MG/L	00930		
			X									Sulfate, Dissolved (as SO_4)	MG/L	00946		
X			X			X			X			Total Dissolved Solids (TDS)	PPM	70300	676	
												Total Organic Carbon (TOC)	PPM	00680		
												Total Organic Halogen (TOX)	UG/L	70353		
												Toxaphene	UG/L	39400		
												Turbidity	NTU	00076		
			X									Zinc, Dissolved	UG/L	01090		
												2, 4–D, Total	UG/L	39370		
												2, 4, 5–TP, Total	UG/L	39045		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-016
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical - Carteret, NJ | SW ID NO.: MW-8

LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. MO. DAY	LAB CERT. NO.	WQM USE
T	NJ 0026077	26-08559-3	890267	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Acrylonitrile	UG/L	34215	25	K
												Benzene	UG/L	34030	9400	
												Bromoform	UG/L	32104	100	K
												Carbon Tetrachloride	UG/L	32102	100	K
												Chlorobenzene	UG/L	34301	11000	
												Chlorodibromoethane	UG/L	34306	100	K
												Chloroform	UG/L	32106	100	K
												1, 1 - Dichloroethane	UG/L	34496	100	K
												1, 2 - Dichloroethane	UG/L	34531	100	K
												1, 1 - Dichloroethylene	UG/L	34501	100	K
												1, 2 - Dichloropropane	UG/L	34541	100	K
												Ethylbenzene	UG/L	34371	100	K
												Methylene Chloride	UG/L	34423	570	
												1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	100	K
												Tetrachloroethylene	UG/L	34475	100	K
												Toluene	UG/L	34012	100	K
												1, 1, 1 - Trichloroethane	UG/L	34505	100	K
												1, 1, 2 - Trichloroethane	UG/L	34511	100	K
												Trichloroethylene	UG/L	39180	100	K
												Vinyl Chloride	UG/L	39175	100	K
												Acrolein	UG/L	34210	25	K
												Chloroethane	UG/L	34311	100	K
												2 - Chloroethylvinyl Ether	UG/L	34576	100	K
												Dichlorobromomethane	UG/L	32105	100	K
												1, 3 - Dichloropropylene	UG/L	34699	100	K
												Methyl Bromide	UG/L	34413	100	K
												Methyl Chloride	UG/L	34418	100	K
												1, 2 - trans - Dichloroethylene	UG/L	34546	100	K
												1, 2 Dichlorobenzene	UG/L	34536	100	K
												1, 3 Dichlorobenzene	UG/L	34566	100	K
												1, 4 Dichlorobenzene	UG/L	34571	100	K

29 42 55 68 — 33 34 46 47 59 60 72 73 — 40 41 53 54 66 67 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
1/83

P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT
ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical - Carteret, NJ	SW ID NO. MW-8
LAB NAME: NANCO Laboratories - Wappingers Falls, NY	

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08559-3	89 02 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

J	F	M	A	M	J	J	A	S	O	N	D	ANALYTES	UNITS	PARAMETER	VALUE	REMARKS
			X						X			2-Chlorophenol	ug/l	34586		
												2,4-Dichlorophenol	ug/l	34601		
												2,4-Dimethylphenol	ug/l	34606		
												2,6-Dinitro-o-cresol	ug/l	77603		
												2,4-Dinitrophenol	ug/l	34616		
												2-Nitrophenol	ug/l	34591		
												4-Nitrophenol	ug/l	34649		
												p-Chloro-m-cresol	ug/l	34452		
												Pentachlorophenol	ug/l	39032		
												Phenol	ug/l	34695		
												2,4,6-Trichlorophenol	ug/l	34621		
												Acenaphthene	ug/l	34205		
												Acenaphthylene	ug/l	34200		
												Anthracene	ug/l	34220		
												Benzidine	ug/l	39120		
												Benzanthracene	ug/l	34526		
												Benzopyrene	ug/l	34247		
												3,4-Benzofluoranthene	ug/l	34230		
												Benzoperylene	ug/l	34521		
												Benzofluoranthene	ug/l	34242		
												Bis(2-chloroethoxy)methane	ug/l	34278		
												Bis(2-chloroethyl) Ether	ug/l	34273		
												Bis(2-chlroisopropyl) Ether	ug/l	34283		
												Bis(2-ethylhexyl) Phthalate	ug/l	39100		
												4-Bromophenyl Ether	ug/l	34636		
												Butylbenzyl Phthalate	ug/l	34292		
												2-Chloronaphthalene	ug/l	34581		
												4-Chlorophenyl Phenyl Ether	ug/l	34641		

VALUE CODING RULES AND

Form VWX-017
4/83
P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ
SW ID NO.: MW-8
LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. MO. DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	26-08559-3	890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

J	F	M	A	M	J	J	A	S	O	N	D	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
			X						X			Chrysene	ug/l	34320		
												Dibenzanthracene	ug/l	34556		
												1,2-Dichlorobenzene	ug/l	34536		
												1,3-Dichlorobenzene	ug/l	34566		
												1,4-Dichlorobenzene	ug/l	34571		
												3,3'-Dichlorobenzidine	ug/l	34631		
												Diethyl Phthalate	ug/l	34336		
												Dimethyl Phthalate	ug/l	34341		
												Di-n-butyl Phthalate	ug/l	39110		
												2,4-Dinitrotolulene	ug/l	34611		
												2,6-Dinitrotolulene	ug/l	34626		
												Di-n-octyl Phthalate	ug/l	34596		
												1,2-Diphenylhydrazine	ug/l	34346		
												Fluoranthene	ug/l	34376		
												Fluorene	ug/l	34381		
												Hexachlorobenzene	ug/l	39700		
												Hexachlorobutadiene	ug/l	34391		
												Hexachlorocyclopentadiene	ug/l	34386		
												Hexachloroethane	ug/l	34396		
												Indenopyrene	ug/l	34403		
												Isophorone	ug/l	34408		
												Naphthalene	ug/l	34696		
												Nitrobenzene	ug/l	34447		
												N-Nitrosodimethylamine	ug/l	34438		
												N-Nitrosodi-n-propylamine	ug/l	34428		
												N-Nitrosodiphenylamine	ug/l	34433		
												Phenanthrene	ug/l	34461		
												Pyrene	ug/l	34469		
												1,2,4-Trichlorobenzene	ug/l	34551		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ
SW ID NO: MW-8

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

U

NJPDES NO.: NJ 0026077

WELL PERMIT NO.: 26-08559-3

SAMPLE DATE (YR. | MO. | DAY): 890207

NJ LAB CERT. NO.: 73460

WQM USE:

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	umhos/cm		1198	
X			X			X			X			Floating Product	inches		0	
X			X			X			X			Total Xylenes	ug/l		100	K

29 33 34 40 41
42 46 47 53 54
55 59 60 66 67
68 72 73 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form T-VWX-014
5/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

MONITORING REPORT – TRANSMITTAL SHEET

NJPDES NO. 0026077

REPORTING PERIOD: MO. YR. 11 88 THRU MO. YR. 01 89

PERMITTEE: Name Unocal Chemical

Address 1345 North Meacham Road
Schaumburg, IL 60196

FACILITY: Name Unocal Chemicals Division

Address 350 Roosevelt Avenue
Carteret (County) Middlesex

Telephone (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY

☐ T-VWX-007 ☐ T-VWX-008 ☐ T-VWX-009

SLUDGE REPORTS - INDUSTRIAL

☐ T-VWX-010A ☐ T-VWX-010B

WASTEWATER REPORTS

☐ T-VWX-011 ☐ T-VWX-012 ☐ T-VWX-013

GROUNDWATER REPORTS

[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT

☐ EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	☐	☒
TEMPORARY BYPASSING	☐	☒
DISINFECTION INTERRUPTION	☐	☒
MONITORING MALFUNCTIONS	☐	☒
UNITS OUT OF OPERATION	☐	☒
OTHER	☐	☒

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inqu of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are signific penalties for submitting false information including the possibility of fine and imprison

LICENSED OPERATOR

Name *(Printed)* ______

Grade & Registry No. ______

Signature ______

Date ______

PRINCIPAL EXECUTIVE OFFICER or
DULY AUTHORIZED REPRESENTATIVE

Name *(Printed)* Daryl W. Dierwechter

Title *(Printed)* Supervisor Environmental Affairs

Signature Daryl W. Dierwechter

Date March 21, 1989

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month |__|__| Year |__|__|

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

Form VWX-015 A
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ
SW ID NO: MW-9
LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0002607	26-08560-2	890206	73460	
1	2 – 8	9 – 16	17 – 22	23 – 27	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		9.89	
X			X			X			X			Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		10.40	
X			X			X			X			Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	2.15	
X			X			X			X			Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	2.66	
			X									Arsenic, Dissolved	UG/L as As	01000		
												Barium, Dissolved	UG/L as Ba	01005		
												Biochemical Oxygen Demand - 5 Day	MG/L	00310		
												Cadmium, Dissolved	UG/L as Cd	01025		
X			X			X			X			Chloride, Dissolved	UG/L as Cl	82295	171900	
												Chromium, Dissolved	UG/L as Cr	01030		
												Chromium, Dissolved, Hexavalent	UG/L as Cr	01220		
												Chemical Oxygen Demand (COD), Dissolved	MG/L	00341		
												Coliform Group	N/100 ML	74056		
												Color	Pt - Co	00080		
												Copper, Dissolved	UG/L as Cu	01040		
												Cyanide, Total	MG/L as CN	00720		
												Endrin, Total	UG/L	39390		
												Fluoride, Dissolved	MG/L as F	00950		
												Gross Alpha, Dissolved	Pc/L	01503		
												Gross Beta, Dissolved	Pc/L	03503		
												Hardness, Total as $CaCO_3$	MG/L	00900		
												Iron, Dissolved	UG/L as Fe	01046		
			X						X			Lead, Dissolved	UG/L as Pb	01049		
												Lindane, Total	UG/L	39782		
												Manganese, Dissolved	UG/L	01055		
			X									Mercury, Dissolved	UG/L	71890		

29 33 34 40 41
42 46 47 53 54
55 59 60 66 67
68 72 73 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-015 B
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-9

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077	26-08560-2	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Methoxychlor, Total	UG/L	39480		
												Methylene Blue Active Substances	MG/L	38260		
												Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
												Nitrogen, Nitrate Dissolved	MG/L as N	00618		
												Odor	T.O.N.	00085		
			X									pH	Standard Units	00400	6.38	
												Phenols, Total Recoverable	UG/L	32730		
												Radium 226, Dissolved	Pc/L	09503		
												Radium 228, Dissolved	Pc/L	81366		
												Selenium, Dissolved	UG/L	01145		
												Silver, Dissolved	UG/L	01075		
												Sodium, Dissolved	MG/L	00930		
			X									Sulfate, Dissolved (as SO_4)	MG/L	00946		
X			X			X			X			Total Dissolved Solids (TDS)	PPM	70300	934	
												Total Organic Carbon (TOC)	PPM	00680		
												Total Organic Halogen (TOX)	UG/L	70353		
												Toxaphene	UG/L	39400		
												Turbidity	NTU	00076		
			X									Zinc, Dissolved	UG/L	01090		
												2, 4—D, Total	UG/L	39370		
												2, 4, 5—TP, Total	UG/L	39045		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-016
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical - Carteret, NJ — S.W. ID NO: MW-9

LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	LAB CERT. NO.	WQM USE
T	NJ 0026077	26-08560-2	890206	73460	
1	2 – 8	9 – 16	17 – 22	23 – 27	28

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Acrylonitrile	UG/L	34215		
												Benzene	UG/L	34030	419	
												Bromoform	UG/L	32104	10	K
												Carbon Tetrachloride	UG/L	32102	10	K
												Chlorobenzene	UG/L	34301	42	
												Chlorodibromomethane	UG/L	34306	10	K
												Chloroform	UG/L	32106	10	K
												1, 1 - Dichloroethane	UG/L	34496	31	
												1, 2 - Dichloroethane	UG/L	34531	10	K
												1, 1 - Dichloroethylene	UG/L	34501	10	K
												1, 2 - Dichloropropane	UG/L	34541	10	K
												Ethylbenzene	UG/L	34371	250	
												Methylene Chloride	UG/L	34423	10	K
												1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	10	K
												Tetrachloroethylene	UG/L	34475	10	K
												Toluene	UG/L	34012	8900	C
												1, 1, 1 - Trichloroethane	UG/L	34506	10	K
												1, 1, 2 - Trichloroethane	UG/L	34511	10	K
												Trichloroethylene	UG/L	39180	10	K
												Vinyl Chloride	UG/L	39175	10	K
												Acrolein	UG/L	34210		
												Chloroethane	UG/L	34311	410	
												2 - Chloroethylvinyl Ether	UG/L	34576	10	K
												Dichlorobromomethane	UG/L	32105	10	K
												1, 3 - Dichloropropylene	UG/L	34699	10	K
												Methyl Bromide	UG/L	34413	10	K
												Methyl Chloride	UG/L	34418	10	K
												1, 2 - trans - Dichloroethylene	UG/L	34545	10	K
												1, 2 Dichlorobenzene	UG/L	34536	10	K
												1, 3 Dichlorobenzene	UG/L	34566	10	K
												1, 4 Dichlorobenzene	UG/L	34571	10	K
														29 42 55 68 – 33 46 59 72	34 47 60 73 – 40 53 66 79	41 54 67 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
(2/83)

P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT
ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME	Unocal Chemical - Carteret, NJ	SW ID NO.	MW-9
LAB NAME	NANCO Laboratories - Wappingers Falls, NY		

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE (YR. / MO. / DAY)	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08560-2	89 02 06	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

												ANALYSES	UNITS	PARAMETER	VALUE	REMARKS
			X						X			2-Chlorophenol	ug/l	34586		
												2,4-Dichlorophenol	ug/l	34601		
												2,4-Dimethylphenol	ug/l	34606		
												2,6-Dinitro-o-cresol	ug/l	77603		
												2,4-Dinitrophenol	ug/l	34616		
												2-Nitrophenol	ug/l	34591		
												4-Nitrophenol	ug/l	34649		
												p-Chloro-m-cresol	ug/l	34452		
												Pentachlorophenol	ug/l	39032		
												Phenol	ug/l	34695		
												2,4,6-Trichlorophenol	ug/l	34621		
												Acenaphthene	ug/l	34205		
												Acenaphthylene	ug/l	34200		
												Anthracene	ug/l	34220		
												Benzidine	ug/l	39120		
												Benzanthracene	ug/l	34526		
												Benzopyrene	ug/l	34247		
												3,4-Benzofluoranthene	ug/l	34230		
												Benzoperylene	ug/l	34521		
												Benzofluoranthene	ug/l	34242		
												Bis(2-chloroethoxy)methane	ug/l	34278		
												Bis(2-chloroethyl) Ether	ug/l	34273		
												Bis(2-chloroisopropyl) Ether	ug/l	34283		
												Bis(2-ethylhexyl) Phthalate	ug/l	39100		
												4-Bromophenyl Ether	ug/l	34636		
												Butylbenzyl Phthalate	ug/l	34292		
												2-Chloronaphthalene	ug/l	34581		
												4-Chlorophenyl Phenyl Ether	ug/l	34641		

VALUE CODING RULES AND

Form VWX-017
4/83
P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME Unocal Chemicals - Carteret, NJ | SW ID NO. MW-9

LAB NAME NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. MO. DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08560-2	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
			X						X			Chrysene	ug/l	34320		
												Dibenzanthracene	ug/l	34556		
												1,2-Dichlorobenzene	ug/l	34536		
												1,3-Dichlorobenzene	ug/l	34566		
												1,4-Dichlorobenzene	ug/l	34571		
												3,3'-Dichlorobenzidine	ug/l	34631		
												Diethyl Phthalate	ug/l	34336		
												Dimethyl Phthalate	ug/l	34341		
												Di-n-butyl Phthalate	ug/l	39110		
												2,4-Dinitrotolulene	ug/l	34611		
												2,6-Dinitrotolulene	ug/l	34626		
												Di-n-octyl Phthalate	ug/l	34596		
												1,2-Diphenylhydrazine	ug/l	34346		
												Fluoranthene	ug/l	34376		
												Fluorene	ug/l	34381		
												Hexachlorobenzene	ug/l	39700		
												Hexachlorobutadiene	ug/l	34391		
												Hexachlorocyclopentadiene	ug/l	34386		
												Hexachloroethane	ug/l	34396		
												Indenopyrene	ug/l	34403		
												Isophorone	ug/l	34408		
												Naphthalene	ug/l	34696		
												Nitrobenzene	ug/l	34447		
												N-Nitrosodimethylamine	ug/l	34438		
												N-Nitrosodi-n-propylamine	ug/l	34428		
												N-Nitrosodiphenylamine	ug/l	34433		
												Phenanthrene	ug/l	34461		
												Pyrene	ug/l	34469		
												1,2,4-Trichlorobenzene	ug/l	34551		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ   SW ID NO: MW-9

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08560-2	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	umhos/cm		950	
X			X			X			X			Floating Product	inches		0	
X			X			X			X			Total Xylenes	ug/l		220	

VALUE CODING RULES AND
REMARK CODES ON REVERSE

5/83

DIVISION OF WATER RESOURCES

MONITORING REPORT — TRANSMITTAL SHEET

NJPDES NO. 0026077

REPORTING PERIOD: MO. YR. 11 88 THRU MO. YR. 01 89

PERMITTEE:

Name Unocal Chemical

Address 1345 North Meacham Road

Schaumburg, IL 60196

FACILITY:

Name Unocal Chemicals Division

Address 350 Roosevelt Avenue

Carteret (County) Middlesex

Telephone (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY

☐ T-VWX-007 ☐ T-VWX-008 ☐ T-VWX-009

SLUDGE REPORTS - INDUSTRIAL

☐ T-VWX-010A ☐ T-VWX-010B

WASTEWATER REPORTS

☐ T-VWX-011 ☐ T-VWX-012 ☐ T-VWX-013

GROUNDWATER REPORTS

1 VWX-015(A,B) 1 VWX-016 1 VWX-017

NPDES DISCHARGE MONITORING REPORT

☐ EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	☐	X
TEMPORARY BYPASSING	☐	X
DISINFECTION INTERRUPTION	☐	X
MONITORING MALFUNCTIONS	☐	X
UNITS OUT OF OPERATION	☐	X
OTHER	☐	X

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inqu of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are signific penalties for submitting false information including the possibility of fine and imprison

LICENSED OPERATOR

Name (Printed) ____________

Grade & Registry No. ____________

Signature ____________

Date ____________

PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE

Name (Printed) Daryl W. Dierwechter

Title (Printed) Supervisor Environmental Affairs

Signature [signature]

Date March 21, 1989

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month [|] Year [|]

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

Form VWX-015 A
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ — SW ID NO: MW-10

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0002 6077	26-08561-5	89 02 06	73460	
1	2 – 8	9 – 16	17 – 22	23 – 27	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE
X			X			X			X			Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		10.32
X			X			X			X			Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		10.83
X			X			X			X			Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	2.40
X			X			X			X			Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	2.91
			X									Arsenic, Dissolved	UG/L as As	01000	
												Barium, Dissolved	UG/L as Ba	01005	
												Biochemical Oxygen Demand - 5 Day	MG/L	00310	
												Cadmium, Dissolved	UG/L as Cd	01025	
X			X			X			X			Chloride, Dissolved	UG/L as Cl	82295	121900
												Chromium, Dissolved	UG/L as Cr	01030	
												Chromium, Dissolved, Hexavalent	UG/L as Cr	01220	
												Chemical Oxygen Demand (COD), Dissolved	MG/L	00341	
												Coliform Group	N/100 ML	74056	
												Color	Pt - Co	00080	
												Copper, Dissolved	UG/L as Cu	01040	
												Cyanide, Total	MG/L as CN	00720	
												Endrin, Total	UG/L	39390	
												Fluoride, Dissolved	MG/L as F	00950	
												Gross Alpha, Dissolved	Pc/L	01503	
												Gross Beta, Dissolved	Pc/L	03503	
												Hardness, Total as $CaCO_3$	MG/L	00900	
												Iron, Dissolved	UG/L as Fe	01045	
			X						X			Lead, Dissolved	UG/L as Pb	01049	
												Lindane, Total	UG/L	39782	
												Manganese, Dissolved	UG/L	01056	
			X									Mercury, Dissolved	UG/L	71890	

VALUE CODING RULES AND REMARK CODES ON REVERSE

Form VWX-015 3
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-10

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077	26-08561-5	89 02 06	73460	
1	2 – 8	9 – 16	17 – 22	23 – 27	33

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Methoxychlor, Total	UG/L	39480		
												Methylene Blue Active Substances	MG/L	38260		
												Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
												Nitrogen, Nitrate Dissolved	MG/L as N	00618		
												Odor	T.O.N.	00085		
			X									pH	Standard Units	00400	6.87	
												Phenols, Total Recoverable	UG/L	32730		
												Radium 226, Dissolved	Pc/L	09503		
												Radium 228, Dissolved	Pc/L	81366		
												Selenium, Dissolved	UG/L	01145		
												Silver, Dissolved	UG/L	01075		
												Sodium, Dissolved	MG/L	00930		
			X									Sulfate, Dissolved (as SO_4)	MG/L	00946		
X			X			X			X			Total Dissolved Solids (TDS)	PPM	70300	564	
												Total Organic Carbon (TOC)	PPM	00680		
												Total Organic Halogen (TOX)	UG/L	70353		
												Toxaphene	UG/L	39400		
												Turbidity	NTU	00075		
			X									Zinc, Dissolved	UG/L	01090		
												2, 4—D, Total	UG/L	39370		
												2, 4, 5—TP, Total	UG/L	39045		

VALUE CODING RULES AND REMARK CODES ON REVERSE

Form VWX-016
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical - Carteret, NJ
S/W ID NO.: MW-10
LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	LAB CERT. NO.	NCM USE
T	NJ 0026077	26-08561-5	890206	73400	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS: Jan. [X] Feb. [ ] Mar. [ ] Apr. [X] May [ ] June [ ] July [X] Aug. [ ] Sept. [ ] Oct. [X] Nov. [ ] Dec. [ ]

ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
Acrylonitrile	UG/L	34215	25	K
Benzene	UG/L	34030	75	
Bromoform	UG/L	32104	1.0	K
Carbon Tetrachloride	UG/L	32102	1.0	K
Chlorobenzene	UG/L	34301	91	
Chlorodibromoethane	UG/L	34306	1.0	K
Chloroform	UG/L	32106	1.0	K
1, 1 - Dichloroethane	UG/L	34496	1.0	K
1, 2 - Dichloroethane	UG/L	34531	1.0	K
1, 1 - Dichloroethylene	UG/L	34501	1.0	K
1, 2 - Dichloropropane	UG/L	34541	1.0	K
Ethylbenzene	UG/L	34371	940	C
Methylene Chloride	UG/L	34423	1.0	K
1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	1.0	K
Tetrachloroethylene	UG/L	34475	1.0	K
Toluene	UG/L	34012	54.7	
1, 1, 1 - Trichloroethane	UG/L	34506	1.0	K
1, 1, 2 - Trichloroethane	UG/L	34511	1.0	K
Trichloroethylene	UG/L	39180	1.0	K
Vinyl Chloride	UG/L	39175	1.0	K
Acrolein	UG/L	34210	25	K
Chloroethane	UG/L	34311	8.1	
2 - Chloroethylvinyl Ether	UG/L	34576	1.0	K
Dichlorobromomethane	UG/L	32101	1.0	K
1, 3 - Dichloropropylene	UG/L	34699	1.0	K
Methyl Bromide	UG/L	34413	1.0	K
Methyl Chloride	UG/L	34418	1.0	K
1, 2 - trans - Dichloroethylene	UG/L	34546	1.0	K
1, 2 Dichlorobenzene	UG/L	34536	1.0	K
1, 3 Dichlorobenzene	UG/L	34566	1.0	K
1, 4 Dichlorobenzene	UG/L	34571	1.0	K

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
1/83

P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT
ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical - Carteret, NJ	SW ID NO.: MW-10
LAB NAME: NANCO Laboratories - Wappingers Falls, NY	

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. MO. DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08561-5	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANALYTES	UNITS	PARAMETER	VALUE	REMARKS
			X						X			2-Chlorophenol	ug/1	34586		
												2,4-Dichlorophenol	ug/1	34601		
												2,4-Dimethylphenol	ug/1	34606		
												2,6-Dinitro-o-cresol	ug/1	77603		
												2,4-Dinitrophenol	ug/1	34616		
												2-Nitrophenol	ug/1	34591		
												4-Nitrophenol	ug/1	34649		
												p-Chloro-m-cresol	ug/1	34452		
												Pentachlorophenol	ug/1	39032		
												Phenol	ug/1	34695		
												2,4,6-Trichlorophenol	ug/1	34621		
												Acenaphthene	ug/1	34205		
												Acenaphthylene	ug/1	34200		
												Anthracene	ug/1	34220		
												Benzidine	ug/1	39120		
												Benzanthracene	ug/1	34526		
												Benzopyrene	ug/1	34247		
												3,4-Benzofluoranthene	ug/1	34230		
												Benzoperylene	ug/1	34521		
												Benzofluoranthene	ug/1	34242		
												Bis(2-chloroethoxy)methane	ug/1	34278		
												Bis(2-chloroethyl) Ether	ug/1	34273		
												Bis(2-chlroisopropyl) Ether	ug/1	34283		
												Bis(2-ethylhexyl) Phthalate	ug/1	39100		
												4-Bromophenyl Ether	ug/1	34636		
												Butylbenzyl Phthalate	ug/1	34292		
												2-Chloronaphthalene	ug/1	34581		
												4-Chlorophenyl Phenyl Ether	ug/1	34641		

VALUE CODING RULES AND

Form VWX-017
4/83
P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ
SW ID NO.: MW-10
LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	26-08561-5	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0188 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANALYTES	UNITS	PARAMETER	VALUE
			X						X			Chrysene	ug/1	34320	
												Dibenzanthracene	ug/1	34556	
												1,2-Dichlorobenzene	ug/1	34536	
												1,3-Dichlorobenzene	ug/1	34566	
												1,4-Dichlorobenzene	ug/1	34571	
												3,3'-Dichlorobenzidine	ug/1	34631	
												Diethyl Phthalate	ug/1	34336	
												Dimethyl Phthalate	ug/1	34341	
												Di-n-butyl Phthalate	ug/1	39110	
												2,4-Dinitrotolulene	ug/1	34611	
												2,6-Dinitrotolulene	ug/1	34626	
												Di-n-octyl Phthalate	ug/1	34596	
												1,2-Diphenylhydrazine	ug/1	34346	
												Fluoranthene	ug/1	34376	
												Fluorene	ug/1	34381	
												Hexachlorobenzene	ug/1	39700	
												Hexachlorobutadiene	ug/1	34391	
												Hexachlorocyclopentadiene	ug/1	34386	
												Hexachloroethane	ug/1	34396	
												Indenopyrene	ug/1	34403	
												Isophorone	ug/1	34408	
												Naphthalene	ug/1	34696	
												Nitrobenzene	ug/1	34447	
												N-Nitrosodimethylamine	ug/1	34438	
												N-Nitrosodi-n-propylamine	ug/1	34428	
												N-Nitrosodiphenylamine	ug/1	34433	
												Phenanthrene	ug/1	34461	
												Pyrene	ug/1	34469	
												1,2,4-Trichlorobenzene	ug/1	34551	

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ — SW ID NO: MW-10

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

U — NJPDES NO.: NJ 0026077 — WELL PERMIT NO.: 26-08561-5 — SAMPLE DATE (YR. | MO. | DAY): 890206 — NJ LAB CERT. NO.: 73460 — WQM USE:

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	umhos/cm		722	
X			X			X			X			Floating Product	inches		0	
X			X			X			X			Total Xylenes	ug/l		2900	C

VALUE CODING RULES AND
REMARK CODES ON REVERSE

5/83

DIVISION OF WATER RESOURCES

MONITORING REPORT — TRANSMITTAL SHEET

NJPDES NO.: 0 0 2 6 0 7 7

REPORTING PERIOD — MO. YR.: 1 1 8 8 THRU MO. YR.: 0 1 8 9

PERMITTEE:

Name: Unocal Chemical

Address: 1345 North Meacham Road

Schaumburg, IL 60196

FACILITY:

Name: Unocal Chemicals Division

Address: 350 Roosevelt Avenue

Carteret (County) Middlesex

Telephone: (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY

[ ] T-VWX-007 [ ] T-VWX-008 [ ] T-VWX-009

SLUDGE REPORTS - INDUSTRIAL

[ ] T-VWX-010A [ ] T-VWX-010B

WASTEWATER REPORTS

[ ] T-VWX-011 [ ] T-VWX-012 [ ] T-VWX-013

GROUNDWATER REPORTS

[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT

[ ] EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	[ ]	[X]
TEMPORARY BYPASSING	[ ]	[X]
DISINFECTION INTERRUPTION	[ ]	[X]
MONITORING MALFUNCTIONS	[ ]	[X]
UNITS OUT OF OPERATION	[ ]	[X]
OTHER	[ ]	[X]

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inqu of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are signific penalties for submitting false information including the possibility of fine and imprisonn

LICENSED OPERATOR

Name (Printed) ____________________

Grade & Registry No. ____________________

Signature ____________________

Date ____________________

PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE

Name (Printed): Daryl W. Dierwechter

Title (Printed): Supervisor Environmental Affairs

Signature: Daryl W. Dierwechter

Date: March 21, 1989

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month

Year

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

Form VWX-015 A
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ
SW ID NO: MW-11
LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0026077	26-08562-3	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS	ANALYSIS	UNITS	PARAMETER	VALUE
Jan., Apr., July, Oct.	Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		10.70
Jan., Apr., July, Oct.	Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		11.25
Jan., Apr., July, Oct.	Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	1.63
Jan., Apr., July, Oct.	Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	2.18
Apr.	Arsenic, Dissolved	UG/L as As	01000	
	Barium, Dissolved	UG/L as Ba	01005	
	Biochemical Oxygen Demand - 5 Day	MG/L	00310	
	Cadmium, Dissolved	UG/L as Cd	01025	
Jan., Apr., July, Oct.	Chloride, Dissolved	UG/L as Cl	82295	37700
	Chromium, Dissolved	UG/L as Cr	01030	
	Chromium, Dissolved, Hexavalent	UG/L as Cr	01220	
	Chemical Oxygen Demand (COD), Dissolved	MG/L	00341	
	Coliform Group	N/100 ML	74056	
	Color	Pt - Co	00080	
	Copper, Dissolved	UG/L as Cu	01040	
	Cyanide, Total	MG/L as CN	00720	
	Endrin, Total	UG/L	39390	
	Fluoride, Dissolved	MG/L as F	00950	
	Gross Alpha, Dissolved	Pc/L	01503	
	Gross Beta, Dissolved	Pc/L	03503	
	Hardness, Total as $CaCO_3$	MG/L	00900	
	Iron, Dissolved	UG/L as Fe	01046	
Apr., Oct.	Lead, Dissolved	UG/L as Pb	01049	
	Lindane, Total	UG/L	39782	
	Manganese, Dissolved	UG/L	01056	
Apr.	Mercury, Dissolved	UG/L	71890	

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-015 B
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-11

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077	26-08562-3	89 02 06	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS (Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.)	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
	Methoxychlor, Total	UG/L	39480		
	Methylene Blue Active Substances	MG/L	38260		
	Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
	Nitrogen, Nitrate Dissolved	MG/L as N	00618		
	Odor	T.O.N.	00085		
X (Apr.)	pH	Standard Units	00400	7.17	
	Phenols, Total Recoverable	UG/L	32730		
	Radium 226, Dissolved	Pc/L	09503		
	Radium 228, Dissolved	Pc/L	81366		
	Selenium, Dissolved	UG/L	01145		
	Silver, Dissolved	UG/L	01075		
	Sodium, Dissolved	MG/L	00930		
X (Apr.)	Sulfate, Dissolved (as SO_4)	MG/L	00946		
X (Jan.), X (Apr.), X (July), X (Oct.)	Total Dissolved Solids (TDS)	PPM	70300	201	
	Total Organic Carbon (TOC)	PPM	00680		
	Total Organic Halogen (TOX)	UG/L	70353		
	Toxaphene	UG/L	39400		
	Turbidity	NTU	00075		
X (Apr.)	Zinc, Dissolved	UG/L	01090		
	2, 4—D, Total	UG/L	39370		
	2, 4, 5—TP, Total	UG/L	39045		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-016
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical - Carteret, NJ — S.W. ID NO: MW-11

LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. MO. DAY	NJ LAB CERT. NO.	WQM USE
T	NJ 0026077	26-08562-3	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS: Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. (marked: Jan., Apr., July, Oct.)

ANALYSIS	UNITS	PARAMETER	VALUE	
Acrylonitrile	UG/L	34215	25	K
Benzene	UG/L	34030	1.0	K
Bromoform	UG/L	32104	1.0	K
Carbon Tetrachloride	UG/L	32102	1.0	K
Chlorobenzene	UG/L	34301	1.4	
Chlorodibromoethane	UG/L	34306	1.0	K
Chloroform	UG/L	32106	1.0	K
1, 1 - Dichloroethane	UG/L	34496	1.0	K
1, 2 - Dichloroethane	UG/L	34531	1.0	K
1, 1 - Dichloroethylene	UG/L	34501	1.0	K
1, 2 - Dichloropropane	UG/L	34541	1.0	K
Ethylbenzene	UG/L	34371	1.0	K
Methylene Chloride	UG/L	34423	1.0	K
1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	1.0	K
Tetrachloroethylene	UG/L	34475	1.0	K
Toluene	UG/L	34012	1.0	K
1, 1, 1 - Trichloroethane	UG/L	34506	1.0	K
1, 1, 2 - Trichloroethane	UG/L	34511	1.0	K
Trichloroethylene	UG/L	39180	1.0	K
Vinyl Chloride	UG/L	39175	1.0	K
Acrolein	UG/L	34210	25	K
Chloroethane	UG/L	34311	1.0	K
2 - Chloroethylvinyl Ether	UG/L	34576	1.0	K
Dichlorobromomethane	UG/L	32105	1.0	K
1, 3 - Dichloropropylene	UG/L	34699	1.0	K
Methyl Bromide	UG/L	34413	1.0	K
Methyl Chloride	UG/L	34418	1.0	K
1, 2 - trans - Dichloroethylene	UG/L	34546	1.0	K
1, 2 Dichlorobenzene	UG/L	34536	1.0	K
1, 3 Dichlorobenzene	UG/L	34566	1.0	K
1, 4 Dichlorobenzene	UG/L	34571	1.0	K

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
UEI

P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical - Carteret, NJ	SW ID NO. MW-11
LAB NAME: NANCO Laboratories - Wappingers Falls, NY	

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08562-3	89 02 06	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0 8 8 8 (MO. YR.) TO 0 8 9 2 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS												ANALYSES	UNITS	PARAMETER	VALUE	REMARKS
			X						X			2-Chlorophenol	ug/1	34586		
												2,4-Dichlorophenol	ug/1	34601		
												2,4-Dimethylphenol	ug/1	34606		
												2,6-Dinitro-o-cresol	ug/1	77603		
												2,4-Dinitrophenol	ug/1	34616		
												2-Nitrophenol	ug/1	34591		
												4-Nitrophenol	ug/1	34649		
												p-Chloro-m-cresol	ug/1	34452		
												Pentachlorophenol	ug/1	39032		
												Phenol	ug/1	34695		
												2,4,6-Trichlorophenol	ug/1	34621		
												Acenaphthene	ug/1	34205		
												Acenaphthylene	ug/1	34200		
												Anthracene	ug/1	34220		
												Benzidine	ug/1	39120		
												Benzanthracene	ug/1	34526		
												Benzopyrene	ug/1	34247		
												3,4-Benzofluoranthene	ug/1	34230		
												Benzoperylene	ug/1	34521		
												Benzofluoranthene	ug/1	34242		
												Bis(2-chloroethoxy)methane	ug/1	34278		
												Bis(2-chloroethyl) Ether	ug/1	34273		
												Bis(2-chlroisopropyl) Ether	ug/1	34283		
												Bis(2-ethylhexyl) Phthalate	ug/1	39100		
												4-Bromophenyl Ether	ug/1	34636		
												Butylbenzyl Phthalate	ug/1	34292		
												2-Chloronaphthalene	ug/1	34581		
												4-Chlorophenyl Phenyl Ether	ug/1	34641		

VALUE CODING RULES AND

Form VWX-017
4/83
P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-11

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

U

NJPDES NO.: NJ 0026077

WELL PERMIT NO.: 26-08562-3

SAMPLE DATE (YR. | MO. | DAY): 890206

NJ LAB CERT. NO.: 73460

WCM USE

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

J	F	M	A	M	J	J	A	S	O	N	D	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
			X						X			Chrysene	ug/l	34320		
												Dibenzanthracene	ug/l	34556		
												1,2-Dichlorobenzene	ug/l	34536		
												1,3-Dichlorobenzene	ug/l	34566		
												1,4-Dichlorobenzene	ug/l	34571		
												3,3'-Dichlorobenzidine	ug/l	34631		
												Diethyl Phthalate	ug/l	34336		
												Dimethyl Phthalate	ug/l	34341		
												Di-n-butyl Phthalate	ug/l	39110		
												2,4-Dinitrotolulene	ug/l	34611		
												2,6-Dinitrotolulene	ug/l	34626		
												Di-n-octyl Phthalate	ug/l	34596		
												1,2-Diphenylhydrazine	ug/l	34346		
												Fluoranthene	ug/l	34376		
												Fluorene	ug/l	34381		
												Hexachlorobenzene	ug/l	39700		
												Hexachlorobutadiene	ug/l	34391		
												Hexachlorocyclopentadiene	ug/l	34386		
												Hexachloroethane	ug/l	34396		
												Indenopyrene	ug/l	34403		
												Isophorone	ug/l	34408		
												Naphthalene	ug/l	34696		
												Nitrobenzene	ug/l	34447		
												N-Nitrosodimethylamine	ug/l	34438		
												N-Nitrosodi-n-propylamine	ug/l	34428		
												N-Nitrosodiphenylamine	ug/l	34433		
												Phenanthrene	ug/l	34461		
												Pyrene	ug/l	34469		
												1,2,4-Trichlorobenzene	ug/l	34551		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ
SW ID NO: MW-11
LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	26-08562-3	89 02 06	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	umhos/cm		279	
X			X			X			X			Floating Product	inches		0	
X			X			X			X			Total Xylenes	ug/l		1.0	K

VALUE CODING RULES AND
REMARK CODES ON REVERSE

DIVISION OF WATER RESOURCES

MONITORING REPORT — TRANSMITTAL SHEET

NJPDES NO. 0026077

REPORTING PERIOD: MO. YR. 11 88 THRU MO. YR. 01 89

PERMITTEE: Name Unocal Chemical

Address 1345 North Meacham Road

Schaumburg, IL 60196

FACILITY: Name Unocal Chemicals Division

Address 350 Roosevelt Avenue

Carteret (County) Middlesex

Telephone (201) 541-4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY

[ ] T-VWX-007 [ ] T-VWX-008 [ ] T-VWX-009

SLUDGE REPORTS - INDUSTRIAL

[ ] T-VWX-010A [ ] T-VWX-010B

WASTEWATER REPORTS

[ ] T-VWX-011 [ ] T-VWX-012 [ ] T-VWX-013

GROUNDWATER REPORTS

[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT

[ ] EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	[ ]	[X]
TEMPORARY BYPASSING	[ ]	[X]
DISINFECTION INTERRUPTION	[ ]	[X]
MONITORING MALFUNCTIONS	[ ]	[X]
UNITS OUT OF OPERATION	[ ]	[X]
OTHER	[ ]	[X]

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with th information submitted in this document and all attachments and that, based on my inc of those individuals immediately responsible for obtaining the information, I believe th submitted information is true, accurate and complete. I am aware that there are signifi penalties for submitting false information including the possibility of fine and impriso

LICENSED OPERATOR	PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE
Name *(Printed)*	Name *(Printed)* Daryl W. Dierwechter
Grade & Registry No.	Title *(Printed)* Supervisor Environmental Affairs
Signature	Signature Daryl W. Dierwechter
Date	Date March 21, 1989

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month [|] Year [|]

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

Form VWX-015 A
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ — SW ID NO: MW-12

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0026077	26-08563-1	890206	73460	
1	2 – 8	9 – 16	17 – 22	23 – 27	28

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS (Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.)	ANALYSIS	UNITS	PARAMETER	VALUE
Jan., Apr., July, Oct.	Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		12.10
Jan., Apr., July, Oct.	Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		12.48
Jan., Apr., July, Oct.	Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	2.16
Jan., Apr., July, Oct.	Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	2.54
Apr.	Arsenic, Dissolved	UG/L as As	01000	
	Barium, Dissolved	UG/L as Ba	01005	
	Biochemical Oxygen Demand - 5 Day	MG/L	00310	
	Cadmium, Dissolved	UG/L as Cd	01025	
Jan., Apr., July, Oct.	Chloride, Dissolved	UG/L as Cl	82295	8740
	Chromium, Dissolved	UG/L as Cr	01030	
	Chromium, Dissolved, Hexavalent	UG/L as Cr	01220	
	Chemical Oxygen Demand (COD), Dissolved	MG/L	00341	
	Coliform Group	N/100 ML	74056	
	Color	Pt - Co	00080	
	Copper, Dissolved	UG/L as Cu	01040	
	Cyanide, Total	MG/L as CN	00720	
	Endrin, Total	UG/L	39390	
	Fluoride, Dissolved	MG/L as F	00950	
	Gross Alpha, Dissolved	Pc/L	01503	
	Gross Beta, Dissolved	Pc/L	03503	
	Hardness, Total as $CaCO_3$	MG/L	00900	
	Iron, Dissolved	UG/L as Fe	01046	
Apr., Oct.	Lead, Dissolved	UG/L as Pb	01049	
	Lindane, Total	UG/L	39782	
	Manganese, Dissolved	UG/L	01056	
Apr.	Mercury, Dissolved	UG/L	71890	

29 33 34 40 41 / 42 46 47 53 54 / 55 59 60 66 67 / 68 72 73 79 80

VALUE CODING RULES AND REMARK CODES ON REVERSE

Form VWX-015 3
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-12

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077	26-08563-1	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Methoxychlor, Total	UG/L	39480		
												Methylene Blue Active Substances	MG/L	38260		
												Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
												Nitrogen, Nitrate Dissolved	MG/L as N	00618		
												Odor	T.O.N.	00085		
			X									pH	Standard Units	00400	7.29	
												Phenols, Total Recoverable	UG/L	32730		
												Radium 226, Dissolved	Pc/L	09503		
												Radium 228, Dissolved	Pc/L	81366		
												Selenium, Dissolved	UG/L	01145		
												Silver, Dissolved	UG/L	01075		
												Sodium, Dissolved	MG/L	00930		
			X									Sulfate, Dissolved (as SO_4)	MG/L	00945		
X			X			X			X			Total Dissolved Solids (TDS)	PPM	70300	208	
												Total Organic Carbon (TOC)	PPM	00680		
												Total Organic Halogen (TOX)	UG/L	70353		
												Toxaphene	UG/L	39400		
												Turbidity	NTU	00076		
			X									Zinc, Dissolved	UG/L	01090		
												2, 4—D, Total	UG/L	39370		
												2, 4, 5—TP, Total	UG/L	39045		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form [illegible]
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical _ Carteret, NJ | SW ID NO: MW-12

LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WCM USE
T	NJ 0026077	26-08563-1	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Acrylonitrile	UG/L	34215	25	K
												Benzene	UG/L	34030	1.0	K
												Bromoform	UG/L	32104	1.0	
												Carbon Tetrachloride	UG/L	32102	1.0	K
												Chlorobenzene	UG/L	34301	1.0	K
												Chlorodibromomethane	UG/L	34306	1.0	K
												Chloroform	UG/L	32106	1.0	K
												1, 1 - Dichloroethane	UG/L	34496	1.0	K
												1, 2 - Dichloroethane	UG/L	34531	1.0	K
												1, 1 - Dichloroethylene	UG/L	34501	1.0	K
												1, 2 - Dichloropropane	UG/L	34541	1.0	
												Ethylbenzene	UG/L	34371	24	
												Methylene Chloride	UG/L	34423	1.0	K
												1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	1.0	K
												Tetrachloroethylene	UG/L	34475	1.0	K
												Toluene	UG/L	34012	1.0	K
												1, 1, 1 - Trichloroethane	UG/L	34505	1.0	K
												1, 1, 2 - Trichloroethane	UG/L	34511	1.0	K
												Trichloroethylene	UG/L	39180	1.0	K
												Vinyl Chloride	UG/L	39175	1.0	K
												Acrolein	UG/L	34210	2.5	K
												Chloroethane	UG/L	34311	1.0	K
												2 - Chloroethylvinyl Ether	UG/L	34576	1.0	K
												Dichlorobromomethane	UG/L	32105	1.0	K
												1, 3 - Dichloropropylene	UG/L	34693	1.0	K
												Methyl Bromide	UG/L	34413	1.0	K
												Methyl Chloride	UG/L	34418	1.0	K
												1, 2 - trans - Dichloroethylene	UG/L	34546	1.0	K
												1, 2 Dichlorobenzene	UG/L	34536	1.0	K
												1, 3 Dichlorobenzene	UG/L	34566	1.0	K
												1, 4 Dichlorobenzene	UG/L	3457[illegible]	1.0	K

29 42 55 68 | 33 34 46 47 59 60 72 73 | 40 41 53 54 66 67 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
U/83

P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical - Carteret, NJ	SW ID NO. MW-12
LAB NAME: NANCO Laboratories - Wappingers Falls, NY	

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08563-1	89 02 06	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
			X						X			2-Chlorophenol	ug/1	34586		
												2,4-Dichlorophenol	ug/1	34601		
												2,4-Dimethylphenol	ug/1	34606		
												2,6-Dinitro-o-cresol	ug/1	77603		
												2,4-Dinitrophenol	ug/1	34616		
												2-Nitrophenol	ug/1	34591		
												4-Nitrophenol	ug/1	34649		
												p-Chloro-m-cresol	ug/1	34452		
												Pentachlorophenol	ug/1	39032		
												Phenol	ug/1	34695		
												2,4,6-Trichlorophenol	ug/1	34621		
												Acenaphthene	ug/1	34205		
												Acenaphthylene	ug/1	34200		
												Anthracene	ug/1	34220		
												Benzidine	ug/1	39120		
												Benzanthracene	ug/1	34526		
												Benzopyrene	ug/1	34247		
												3,4-Benzofluoranthene	ug/1	34230		
												Benzoperylene	ug/1	34521		
												Benzofluoranthene	ug/1	34242		
												Bis(2-chloroethoxy)methane	ug/1	34278		
												Bis(2-chloroethyl) Ether	ug/1	34273		
												Bis(2-chlroisopropyl) Ether	ug/1	34283		
												Bis(2-ethylhexyl) Phthalate	ug/1	39100		
												4-Bromophenyl Ether	ug/1	34636		
												Butylbenzyl Phthalate	ug/1	34292		
												2-Chloronaphthalene	ug/1	34581		
												4-Chlorophenyl Phenyl Ether	ug/1	34641		

VALUE CODING RULES AND

Form VWX-017
4/83
P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECT
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ
SW ID NO. MW-12
LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. MO. DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	26-08563-1	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

J	F	M	A	M	J	J	A	S	O	N	D	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
			X						X			Chrysene	ug/1	34320		
												Dibenzanthracene	ug/1	34556		
												1,2-Dichlorobenzene	ug/1	34536		
												1,3-Dichlorobenzene	ug/1	34566		
												1,4-Dichlorobenzene	ug/1	34571		
												3,3'-Dichlorobenzidine	ug/1	34631		
												Diethyl Phthalate	ug/1	34336		
												Dimethyl Phthalate	ug/1	34341		
												Di-n-butyl Phthalate	ug/1	39110		
												2,4-Dinitrotolulene	ug/1	34611		
												2,6-Dinitrotolulene	ug/1	34626		
												Di-n-octyl Phthalate	ug/1	34596		
												1,2-Diphenylhydrazine	ug/1	34346		
												Fluoranthene	ug/1	34376		
												Fluorene	ug/1	34381		
												Hexachlorobenzene	ug/1	39700		
												Hexachlorobutadiene	ug/1	34391		
												Hexachlorocyclopentadiene	ug/1	34386		
												Hexachloroethane	ug/1	34396		
												Indenopyrene	ug/1	34403		
												Isophorone	ug/1	34408		
												Naphthalene	ug/1	34696		
												Nitrobenzene	ug/1	34447		
												N-Nitrosodimethylamine	ug/1	34438		
												N-Nitrosodi-n-propylamine	ug/1	34428		
												N-Nitrosodiphenylamine	ug/1	34433		
												Phenanthrene	ug/1	34461		
												Pyrene	ug/1	34469		
												1,2,4-Trichlorobenzene	ug/1	34551		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ — SW ID NO: MW-12

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-08563-1	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	mhos/cm		263	
X			X			X			X			Floating Product	inches		0	
X			X			X			X			Total Xylenes	ug/l		1.0	K

VALUE CODING RULES AND
REMARK CODES ON REVERSE

3/84

DIVISION OF WATER RESOURCES

MONITORING REPORT — TRANSMITTAL SHEET

NPDES NO. 0026077

REPORTING PERIOD: MO. YR. 11 88 THRU MO. YR. 01 89

PERMITTEE: Name Unocal Chemical

Address 1345 North Meacham Road

Schaumburg, IL 60196

FACILITY: Name Unocal Chemicals Division

Address 350 Roosevelt Avenue

Carteret (County) Middlesex

Telephone (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY

[ ] T-VWX-007 [ ] T-VWX-008 [ ] T-VWX-009

SLUDGE REPORTS - INDUSTRIAL

[ ] T-VWX-010A [ ] T-VWX-010B

WASTEWATER REPORTS

[ ] T-VWX-011 [ ] T-VWX-012 [ ] T-VWX-013

GROUNDWATER REPORTS

[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT

[ ] EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	[ ]	[X]
TEMPORARY BYPASSING	[ ]	[X]
DISINFECTION INTERRUPTION	[ ]	[X]
MONITORING MALFUNCTIONS	[ ]	[X]
UNITS OUT OF OPERATION	[ ]	[X]
OTHER	[ ]	[X]

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inq of those individuals immediately responsible for obtaining the information, I believe th submitted information is true, accurate and complete. I am aware that there are signifi penalties for submitting false information including the possibility of fine and imprison

LICENSED OPERATOR

Name (Printed) ______

Grade & Registry No. ______

Signature ______

Date ______

PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE

Name (Printed) Daryl W. Dierwechter

Title (Printed) Supervisor Environmental Affairs

Signature Daryl W. Dierwechter

Date March 21, 1989

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month

Year

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

Form VWX-015 A
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ

SW ID NO: MW-13

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0002 6077	26-09350-2	89 02 06	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE
X			X			X			X			Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		11.74
X			X			X			X			Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		12.30
X			X			X			X			Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	2.16
X			X			X			X			Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	2.72
			X									Arsenic, Dissolved	UG/L as As	01000	
												Barium, Dissolved	UG/L as Ba	01005	
												Biochemical Oxygen Demand - 5 Day	MG/L	00310	
												Cadmium, Dissolved	UG/L as Cd	01025	
X			X			X			X			Chloride, Dissolved	UG/L as Cl	82295	17800
												Chromium, Dissolved	UG/L as Cr	01030	
												Chromium, Dissolved, Hexavalent	UG/L as Cr	01220	
												Chemical Oxygen Demand (COD), Dissolved	MG/L	00341	
												Coliform Group	N/100 ML	74056	
												Color	Pt - Co	00080	
												Copper, Dissolved	UG/L as Cu	01040	
												Cyanide, Total	MG/L as CN	00720	
												Endrin, Total	UG/L	39390	
												Fluoride, Dissolved	MG/L as F	00950	
												Gross Alpha, Dissolved	Pc/L	01503	
												Gross Beta, Dissolved	Pc/L	03503	
												Hardness, Total as $CaCO_3$	MG/L	00900	
												Iron, Dissolved	UG/L as Fe	01046	
			X						X			Lead, Dissolved	UG/L as Pb	01049	
												Lindane, Total	UG/L	39782	
												Manganese, Dissolved	UG/L	01056	
			X									Mercury, Dissolved	UG/L	71890	

29 33 34 40 41
42 46 47 53 54
55 59 60 66 67
68 72 73 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-13

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077	26-09350-2	89 02 06	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 01 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Methoxychlor, Total	UG/L	39480		
												Methylene Blue Active Substances	MG/L	38260		
												Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
												Nitrogen, Nitrate Dissolved	MG/L as N	00618		
												Odor	T.O.N.	00085		
			X									pH	Standard Units	00400	7.47	
												Phenols, Total Recoverable	UG/L	32730		
												Radium 226, Dissolved	Pc/L	09503		
												Radium 228, Dissolved	Pc/L	81366		
												Selenium, Dissolved	UG/L	01145		
												Silver, Dissolved	UG/L	01075		
												Sodium, Dissolved	MG/L	00930		
			X									Sulfate, Dissolved (as SO_4)	MG/L	00946		
X			X			X			X			Total Dissolved Solids (TDS)	PPM	70300	255	
												Total Organic Carbon (TOC)	PPM	00680		
												Total Organic Halogen (TOX)	UG/L	70353		
												Toxaphene	UG/L	39400		
												Turbidity	NTU	00075		
			X									Zinc, Dissolved	UG/L	01090		
												2, 4—D, Total	UG/L	39370		
												2, 4, 5—TP, Total	UG/L	39045		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-016
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical - Carteret, NJ
S.W. ID NO.: MW-13

LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	LAB CERT. NO.	WQM USE
T	NJ 0026077	26-093500-2	89 02 06	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS: Jan. X, Apr. X, July X, Oct. X

ANALYSIS	UNITS	PARAMETER	VALUE	
Acrylonitrile	UG/L	34215	25	K
Benzene	UG/L	34030	3.8	
Bromoform	UG/L	32104	1.0	K
Carbon Tetrachloride	UG/L	32102	1.0	K
Chlorobenzene	UG/L	34301	1.0	K
Chlorodibromoethane	UG/L	34306	1.0	K
Chloroform	UG/L	32106	1.0	K
1, 1 - Dichloroethane	UG/L	34496	1.2	
1, 2 - Dichloroethane	UG/L	34531	1.0	K
1, 1 - Dichloroethylene	UG/L	34501	1.0	K
1, 2 - Dichloropropane	UG/L	34541	1.0	K
Ethylbenzene	UG/L	34371	1.0	K
Methylene Chloride	UG/L	34423	1.0	K
1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	1.0	K
Tetrachloroethylene	UG/L	34475	1.0	K
Toluene	UG/L	34012	1.0	K
1, 1, 1 - Trichloroethane	UG/L	34506	9.6	
1, 1, 2 - Trichloroethane	UG/L	34511	1.0	K
Trichloroethylene	UG/L	39130	1.0	K
Vinyl Chloride	UG/L	39175	1.0	K
Acrolein	UG/L	34210	25	K
Chloroethane	UG/L	34311	1.0	K
2 - Chloroethylvinyl Ether	UG/L	34576	1.0	K
Dichlorobromomethane	UG/L	32105	1.0	K
1, 3 - Dichloropropylene	UG/L	34699	1.0	K
Methyl Bromide	UG/L	34413	1.0	K
Methyl Chloride	UG/L	34418	1.0	K
1, 2 - trans - Dichloroethylene	UG/L	34546	1.0	K
1, 2 Dichlorobenzene	UG/L	34536	1.0	K
1, 3 Dichlorobenzene	UG/L	34566	1.0	K
1, 4 Dichlorobenzene	UG/L	34571	1.0	K

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT
ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical - Carteret, NJ	SW ID NO. MW-13
LAB NAME: NANCO Laboratories - Wappingers Falls, NY	

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. MO. DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-09350-2	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANALYSES	UNITS	PARAMETER	VALUE	REMARKS
			X						X			2-Chlorophenol	ug/l	34586		
												2,4-Dichlorophenol	ug/l	34601		
												2,4-Dimethylphenol	ug/l	34606		
												2,6-Dinitro-o-cresol	ug/l	77603		
												2,4-Dinitrophenol	ug/l	34616		
												2-Nitrophenol	ug/l	34591		
												4-Nitrophenol	ug/l	34649		
												p-Chloro-m-cresol	ug/l	34452		
												Pentachlorophenol	ug/l	39032		
												Phenol	ug/l	34695		
												2,4,6-Trichlorophenol	ug/l	34621		
												Acenaphthene	ug/l	34205		
												Acenaphthylene	ug/l	34200		
												Anthracene	ug/l	34220		
												Benzidine	ug/l	39120		
												Benzanthracene	ug/l	34526		
												Benzopyrene	ug/l	34247		
												3,4-Benzofluoranthene	ug/l	34230		
												Benzoperylene	ug/l	34521		
												Benzofluoranthene	ug/l	34242		
												Bis(2-chloroethoxy)methane	ug/l	34278		
												Bis(2-chloroethyl) Ether	ug/l	34273		
												Bis(2-chlroisopropyl) Ether	ug/l	34283		
												Bis(2-ethylhexyl) Phthalate	ug/l	39100		
												4-Bromophenyl Ether	ug/l	34636		
												Butylbenzyl Phthalate	ug/l	34292		
												2-Chloronaphthalene	ug/l	34581		
												4-Chlorophenyl Phenyl Ether	ug/l	34641		

VALUE CODING RULES AND

Form VWX-017
4/83
P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT
ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ | SW ID NO. MW-13

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-09350-2	89 02 06	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS: J	F	M	A	M	J	J	A	S	O	N	D	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
			X						X			Chrysene	ug/1	34320		
												Dibenzanthracene	ug/1	34556		
												1,2-Dichlorobenzene	ug/1	34536		
												1,3-Dichlorobenzene	ug/1	34566		
												1,4-Dichlorobenzene	ug/1	34571		
												3,3'-Dichlorobenzidine	ug/1	34631		
												Diethyl Phthalate	ug/1	34336		
												Dimethyl Phthalate	ug/1	34341		
												Di-n-butyl Phthalate	ug/1	39110		
												2,4-Dinitrotolulene	ug/1	34611		
												2,6-Dinitrotolulene	ug/1	34626		
												Di-n-octyl Phthalate	ug/1	34596		
												1,2-Diphenylhydrazine	ug/1	34346		
												Fluoranthene	ug/1	34376		
												Fluorene	ug/1	34381		
												Hexachlorobenzene	ug/1	39700		
												Hexachlorobutadiene	ug/1	34391		
												Hexachlorocyclopentadiene	ug/1	34386		
												Hexachloroethane	ug/1	34396		
												Indenopyrene	ug/1	34403		
												Isophorone	ug/1	34408		
												Naphthalene	ug/1	34696		
												Nitrobenzene	ug/1	34447		
												N-Nitrosodimethylamine	ug/1	34438		
												N-Nitrosodi-n-propylamine	ug/1	34428		
												N-Nitrosodiphenylamine	ug/1	34433		
												Phenanthrene	ug/1	34461		
												Pyrene	ug/1	34469		
												1,2,4-Trichlorobenzene	ug/1	34551		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ
SW ID NO: MW-13
LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	26-09350-2	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	mhos/cm		314	
X			X			X			X			Floating Product	inches		0	
X			X			X			X			Total Xylenes	ug/l		1.0	K

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form T-VWX-014
5/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

MONITORING REPORT — TRANSMITTAL SHEET

NJPDES NO.	REPORTING PERIOD MO. YR.		MO. YR.
0 0 2 6 0 7 7	1 1 8 8	THRU	0 1 8 9

PERMITTEE: Name Unocal Chemical

Address 1345 North Meacham Road

Schaumburg, IL 60196

FACILITY: Name Unocal Chemicals Division

Address 350 Roosevelt Avenue

Carteret (County) Middlesex

Telephone (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY

[ ] T-VWX-007 [ ] T-VWX-008 [ ] T-VWX-009

SLUDGE REPORTS - INDUSTRIAL

[ ] T-VWX-010A [ ] T-VWX-010B

WASTEWATER REPORTS

[ ] T-VWX-011 [ ] T-VWX-012 [ ] T-VWX-013

GROUNDWATER REPORTS

[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT

[ ] EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	[ ]	[X]
TEMPORARY BYPASSING	[ ]	[X]
DISINFECTION INTERRUPTION	[ ]	[X]
MONITORING MALFUNCTIONS	[ ]	[X]
UNITS OUT OF OPERATION	[ ]	[X]
OTHER	[ ]	[X]

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inq of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are signific penalties for submitting false information including the possibility of fine and imprison

LICENSED OPERATOR

Name (Printed)

Grade & Registry No.

Signature

Date

PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE

Name (Printed) Daryl W. Dierwechter

Title (Printed) Supervisor Environmental Affairs

Signature Daryl W. Dierwechter

Date March 21, 1989

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month [|] Year [|]

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	25	27	28	29	30	31	
Licensed Operator																
Others																

Form VWX-015 A
4/83

W JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

WATER QUALITY MANAGEMENT ELEMENT

GRO UD WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ

SW ID NO: MW-14

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0 0 2 6 0 7 7	2 6 - 0 9 3 5 1 - 1	8 9 0 2 0 6	7 3 4 6 0	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0 8 8 8 (MO. YR.) TO 0 8 9 2 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE
X			X			X			X			Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		12.53
X			X			X			X			Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		13.35
X			X			X			X			Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	14.97
X			X			X			X			Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	15.79
			X									Arsenic, Dissolved	UG/L as As	01000	
												Barium, Dissolved	UG/L as Ba	01005	
												Biochemical Oxygen Demand - 5 Day	MG/L	00310	
												Cadmium, Dissolved	UG/L as Cd	01025	
X			X			X			X			Chloride, Dissolved	UG/L as Cl	82295	32100
												Chromium, Dissolved	UG/L as Cr	01030	
												Chromium, Dissolved, Hexavalent	UG/L as Cr	01220	
												Chemical Oxygen Demand (COD), Dissolved	MG/L	00341	
												Coliform Group	N/100 ML	74056	
												Color	Pt - Co	00080	
												Copper, Dissolved	UG/L as Cu	01040	
												Cyanide, Total	MG/L as CN	00720	
												Endrin, Total	UG/L	39390	
												Fluoride, Dissolved	MG/L as F	00950	
												Gross Alpha, Dissolved	Pc/L	01503	
												Gross Beta, Dissolved	Pc/L	03503	
												Hardness, Total as $CaCO_3$	MG/L	00900	
												Iron, Dissolved	UG/L as Fe	01046	
			X						X			Lead, Dissolved	UG/L as Pb	01049	
												Lindane, Total	UG/L	39782	
												Manganese, Dissolved	UG/L	01056	
			X									Mercury, Dissolved	UG/L	71890	

VALUE CODING RULES AND
REMARK CODES ON REVERSE

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-14

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077	26-09351-1	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Methoxychlor, Total	UG/L	39480		
												Methylene Blue Active Substances	MG/L	38260		
												Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
												Nitrogen, Nitrate, Dissolved	MG/L as N	00618		
												Odor	T.O.N.	00095		
			X									pH	Standard Units	00400	7.41	
												Phenols, Total Recoverable	UG/L	32730		
												Radium 226, Dissolved	Pc/L	09503		
												Radium 228, Dissolved	Pc/L	81366		
												Selenium, Dissolved	UG/L	01145		
												Silver, Dissolved	UG/L	01075		
												Sodium, Dissolved	MG/L	00930		
			X									Sulfate, Dissolved (as SO_4)	MG/L	00946		
X			X			X			X			Total Dissolved Solids (TDS)	PPM	70300	512	
												Total Organic Carbon (TOC)	PPM	00680		
												Total Organic Halogen (TOX)	UG/L	70353		
												Toxaphene	UG/L	39400		
												Turbidity	NTU	00076		
			X									Zinc, Dissolved	UG/L	01090		
												2, 4—D, Total	UG/L	39370		
												2, 4, 5—TP, Total	UG/L	39045		

VALUE CODING RULES AND REMARK CODES ON REVERSE

Form VWX-016
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical - Carteret, NJ
SW ID NO: MW-14
LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. MO. DAY	LAB CERT. NO.	WCM USE
T	NJ 0026077	26-09351-1	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Acrylonitrile	UG/L	34215	25	K
												Benzene	UG/L	34030	6.2	
												Bromoform	UG/L	32104	1.0	K
												Carbon Tetrachloride	UG/L	32102	1.0	K
												Chlorobenzene	UG/L	34301	1.0	K
												Chlorodibromoethane	UG/L	34306	1.0	K
												Chloroform	UG/L	32106	1.0	K
												1, 1 - Dichloroethane	UG/L	34496	1.0	K
												1, 2 - Dichloroethane	UG/L	34531	1.0	K
												1, 1 - Dichloroethylene	UG/L	34501	1.0	K
												1, 2 - Dichloropropane	UG/L	34541	1.0	K
												Ethylbenzene	UG/L	34371	4.3	
												Methylene Chloride	UG/L	34423	1.0	K
												1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	1.0	K
												Tetrachloroethylene	UG/L	34475	1.0	K
												Toluene	UG/L	34012	1.0	K
												1, 1, 1 - Trichloroethane	UG/L	34506	1.0	K
												1, 1, 2 - Trichloroethane	UG/L	34511	1.0	K
												Trichloroethylene	UG/L	39130	1.0	K
												Vinyl Chloride	UG/L	39175	1.0	K
												Acrolein	UG/L	34210	25	K
												Chloroethane	UG/L	34311	1.0	K
												2 - Chloroethylvinyl Ether	UG/L	34576	1.0	K
												Dichlorobromomethane	UG/L	32105	1.0	K
												1, 3 - Dichloropropylene	UG/L	34599	1.0	K
												Methyl Bromide	UG/L	34413	1.0	K
												Methyl Chloride	UG/L	34418	1.0	K
												1, 2 - trans - Dichloroethylene	UG/L	34546	1.0	K
												1, 2 Dichlorobenzene	UG/L	34536	1.0	K
												1, 3 Dichlorobenzene	UG/L	34566	1.0	K
												1, 4 Dichlorobenzene	UG/L	34571	1.0	K

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT
ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical - Carteret, NJ	SW ID NO. MW-14
LAB NAME: NANCO Laboratories - Wappingers Falls, NY	

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-09351-1	89 02 06	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANALYTES	UNITS	PARAMETER	VALUE	REMARKS
			X						X			2-Chlorophenol	ug/l	34586		
												2,4-Dichlorophenol	ug/l	34601		
												2,4-Dimethylphenol	ug/l	34606		
												2,6-Dinitro-o-cresol	ug/l	77603		
												2,4-Dinitrophenol	ug/l	34616		
												2-Nitrophenol	ug/l	34591		
												4-Nitrophenol	ug/l	34649		
												p-Chloro-m-cresol	ug/l	34452		
												Pentachlorophenol	ug/l	39032		
												Phenol	ug/l	34695		
												2,4,6-Trichlorophenol	ug/l	34621		
												Acenaphthene	ug/l	34205		
												Acenaphthylene	ug/l	34200		
												Anthracene	ug/l	34220		
												Benzidine	ug/l	39120		
												Benzanthracene	ug/l	34526		
												Benzopyrene	ug/l	34247		
												3,4-Benzofluoranthene	ug/l	34230		
												Benzoperylene	ug/l	34521		
												Benzofluoranthene	ug/l	34242		
												Bis(2-chloroethoxy)methane	ug/l	34278		
												Bis(2-chloroethyl) Ether	ug/l	34273		
												Bis(2-chlroisopropyl) Ether	ug/l	34283		
												Bis(2-ethylhexyl) Phthalate	ug/l	39100		
												4-Bromophenyl Ether	ug/l	34636		
												Butylbenzyl Phthalate	ug/l	34292		
												2-Chloronaphthalene	ug/l	34581		
												4-Chlorophenyl Phenyl Ether	ug/l	34641		

VALUE CODING RULES AND

Form VWX-017
4/83
P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ | SW ID NO. MW-14

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

U | NJPDES NO. NJ 0026077 | WELL PERMIT NO. 26-09351-1 | SAMPLE DATE YR. | MO. | DAY 890206 | NJ LAB CERT. NO. 73460 | WQM USE

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
			X						X			Chrysene	ug/1	34320		
												Dibenzanthracene	ug/1	34556		
												1,2-Dichlorobenzene	ug/1	34536		
												1,3-Dichlorobenzene	ug/1	34566		
												1,4-Dichlorobenzene	ug/1	34571		
												3,3'-Dichlorobenzidine	ug/1	34631		
												Diethyl Phthalate	ug/1	34336		
												Dimethyl Phthalate	ug/1	34341		
												Di-n-butyl Phthalate	ug/1	39110		
												2,4-Dinitrotolulene	ug/1	34611		
												2,6-Dinitrotolulene	ug/1	34626		
												Di-n-octyl Phthalate	ug/1	34596		
												1,2-Diphenylhydrazine	ug/1	34346		
												Fluoranthene	ug/1	34376		
												Fluorene	ug/1	34381		
												Hexachlorobenzene	ug/1	39700		
												Hexachlorobutadiene	ug/1	34391		
												Hexachlorocyclopentadiene	ug/1	34386		
												Hexachloroethane	ug/1	34396		
												Indenopyrene	ug/1	34403		
												Isophorone	ug/1	34408		
												Naphthalene	ug/1	34696		
												Nitrobenzene	ug/1	34447		
												N-Nitrosodimethylamine	ug/1	34438		
												N-Nitrosodi-n-propylamine	ug/1	34428		
												N-Nitrosodiphenylamine	ug/1	34433		
												Phenanthrene	ug/1	34461		
												Pyrene	ug/1	34469		
												1,2,4-Trichlorobenzene	ug/1	34551		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ | SW ID NO: MW-14

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-09351-1	890206	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	mhos/cm		596	
X			X			X			X			Floating Product	inches		0	
X			X			X			X			Total Xylenes	ug/l		1.0	

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form T-VWX-014
5/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

MONITORING REPORT — TRANSMITTAL SHEET

NJPDES NO. 0|0|2|6|0|7|7

REPORTING PERIOD: MO. YR. ___ THRU MO. YR. ___

PERMITTEE:

Name: Unocal Chemical

Address: 1345 North Meacham Road

Schaumburg, IL 60196

FACILITY:

Name: Unocal Chemicals Division

Address: 350 Roosevelt Avenue

Carteret (County) Middlesex

Telephone (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY

[ ] T-VWX-007 [ ] T-VWX-008 [ ] T-VWX-009

SLUDGE REPORTS - INDUSTRIAL

[ ] T-VWX-010A [ ] T-VWX-010B

WASTEWATER REPORTS

[ ] T-VWX-011 [ ] T-VWX-012 [ ] T-VWX-013

GROUNDWATER REPORTS

[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT

[ ] EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	[ ]	[X]
TEMPORARY BYPASSING	[ ]	[X]
DISINFECTION INTERRUPTION	[ ]	[X]
MONITORING MALFUNCTIONS	[ ]	[X]
UNITS OUT OF OPERATION	[ ]	[X]
OTHER	[ ]	[X]

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inq of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are signific penalties for submitting false information including the possibility of fine and imprisonn

LICENSED OPERATOR

Name *(Printed)* ___

Grade & Registry No. ___

Signature ___

Date ___

PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE

Name *(Printed)* Daryl W. Dierwechter

Title *(Printed)* Supervisor Environmental Affairs

Signature Daryl W. Dierwechter

Date March 21, 1989

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month ☐☐ Year ☐☐

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

Form VWX-015 A
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ | SW ID NO: MW-16

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0002607	26-09353-7		73460	
1	2 — 8	9 — 16	17 — 22	23 — 27	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE
X			X			X			X			Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		9.23
X			X			X			X			Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		9.60
X			X			X			X			Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	
X			X			X			X			Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	
X			X			X			X			Arsenic, Dissolved	UG/L as As	01000	
												Barium, Dissolved	UG/L as Ba	01005	
												Biochemical Oxygen Demand - 5 Day	MG/L	00310	
												Cadmium, Dissolved	UG/L as Cd	01025	
X			X			X			X			Chloride, Dissolved	UG/L as Cl	82295	
												Chromium, Dissolved	UG/L as Cr	01030	
												Chromium, Dissolved, Hexavalent	UG/L as Cr	01220	
												Chemical Oxygen Demand (COD), Dissolved	MG/L	00341	
												Coliform Group	N/100 ML	74056	
												Color	Pt - Co	00080	
												Copper, Dissolved	UG/L as Cu	01040	
												Cyanide, Total	MG/L as CN	00720	
												Endrin, Total	UG/L	39390	
												Fluoride, Dissolved	MG/L as F	00950	
												Gross Alpha, Dissolved	Pc/L	01503	
												Gross Beta, Dissolved	Pc/L	03503	
												Hardness, Total as $CaCO_3$	MG/L	00900	
												Iron, Dissolved	UG/L as Fe	01046	
X			X			X			X			Lead, Dissolved	UG/L as Pb	01049	
												Lindane, Total	UG/L	39782	
												Manganese, Dissolved	UG/L	01056	
X			X			X			X			Mercury, Dissolved	UG/L	71890	

29 33 34 40 41
42 46 47 53 54
55 59 60 66 67
68 72 73 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-015 B
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ
SW ID NO.: MW-16
LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WCM USE
S	NJ 0026077	26-09353-7		73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Methoxychlor, Total	UG/L	39480		
												Methylene Blue Active Substances	MG/L	38260		
												Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
												Nitrogen, Nitrate, Dissolved	MG/L as N	00618		
												Odor	T.O.N.	00085		
X			X			X			X			pH	Standard Units	00400		
												Phenols, Total Recoverable	UG/L	32730		
												Radium 226, Dissolved	Pc/L	09503		
												Radium 228, Dissolved	Pc/L	81366		
												Selenium, Dissolved	UG/L	01145		
												Silver, Dissolved	UG/L	01075		
												Sodium, Dissolved	MG/L	00930		
X			X			X			X			Sulfate, Dissolved (as SO_4)	MG/L	00946		
X			X			X			X			Total Dissolved Solids (TDS)	PPM	70300		
												Total Organic Carbon (TOC)	PPM	00680		
												Total Organic Halogen (TOX)	UG/L	70353		
												Toxaphene	UG/L	39400		
												Turbidity	NTU	00076		
X			X			X			X			Zinc, Dissolved	UG/L	01090		
												2, 4–D, Total	UG/L	39730		
												2, 4, 5–TP, Total	UG/L	39045		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-015
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: UnocalChemical - Carteret, NJ | SW ID NO: MW-16

LAB NAME: NANCO Laboratories- Wappinger Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. MO. DAY	LAB CERT. NO.	WQM USE
T	NJ 0026077	26-09353-7		73460	
1	2 – 8	9 – 16	17 – 22	23 – 27	28

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Acrylonitrile	UG/L	34215		
												Benzene	UG/L	34030		
												Bromoform	UG/L	32104		
												Carbon Tetrachloride	UG/L	32102		
												Chlorobenzene	UG/L	34301		
												Chlorodibromoethane	UG/L	34306		
												Chloroform	UG/L	32106		
												1, 1 - Dichloroethane	UG/L	34496		
												1, 2 - Dichloroethane	UG/L	34531		
												1, 1 - Dichloroethylene	UG/L	34501		
												1, 2 - Dichloropropane	UG/L	34541		
												Ethylbenzene	UG/L	34371		
												Methylene Chloride	UG/L	34423		
												1, 1, 2, 2 - Tetrachloroethane	UG/L	34516		
												Tetrachloroethylene	UG/L	34475		
												Toluene	UG/L	34010		
												1, 1, 1 - Trichloroethane	UG/L	34506		
												1, 1, 2 - Trichloroethane	UG/L	34511		
												Trichloroethylene	UG/L	39180		
												Vinyl Chloride	UG/L	39175		
												Acrolein	UG/L	34210		
												Chloroethane	UG/L	34311		
												2 - Chloroethylvinyl Ether	UG/L	34576		
												Dichlorobromomethane	UG/L	32101		
												1, 3 - Dichloropropylene	UG/L	34699		
												Methyl Bromide	UG/L	34413		
												Methyl Chloride	UG/L	34418		
												1, 2 - trans - Dichloroethylene	UG/L	34546		
												1, 2 Dichlorobenzene	UG/L	34536		
												1, 3 Dichlorobenzene	UG/L	34566		
												1, 4 Dichlorobenzene	UG/L	34571		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT
ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical - Carteret, NJ	SW ID NO.: MW-16
LAB NAME: NANCO Laboratories - Wappingers Falls, NY	

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE (YR. / MO. / DAY)	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	26-09353-7		73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
			X						X			2-Chlorophenol	ug/l	34586		
												2,4-Dichlorophenol	ug/l	34601		
												2,4-Dimethylphenol	ug/l	34606		
												2,6-Dinitro-o-cresol	ug/l	77603		
												2,4-Dinitrophenol	ug/l	34616		
												2-Nitrophenol	ug/l	34591		
												4-Nitrophenol	ug/l	34649		
												p-Chloro-m-cresol	ug/l	34452		
												Pentachlorophenol	ug/l	39032		
												Phenol	ug/l	34695		
												2,4,6-Trichlorophenol	ug/l	34621		
												Acenaphthene	ug/l	34205		
												Acenaphthylene	ug/l	34200		
												Anthracene	ug/l	34220		
												Benzidine	ug/l	39120		
												Benzanthracene	ug/l	34526		
												Benzopyrene	ug/l	34247		
												3,4-Benzofluoranthene	ug/l	34230		
												Benzoperylene	ug/l	34521		
												Benzofluoranthene	ug/l	34242		
												Bis(2-chloroethoxy)methane	ug/l	34278		
												Bis(2-chloroethyl) Ether	ug/l	34273		
												Bis(2-chlroisopropyl) Ether	ug/l	34283		
												Bis(2-ethylhexyl) Phthalate	ug/l	39100		
												4-Bromophenyl Ether	ug/l	34636		
												Butylbenzyl Phthalate	ug/l	34292		
												2-Chloronaphthalene	ug/l	34581		
												4-Chlorophenyl Phenyl Ether	ug/l	34641		

VALUE CODING RULES AND

Form VWX-017
4/83
P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-16

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

U

NPDES NO.: NJ 0 0 2 6 0 7 7

WELL PERMIT NO.: 2 6 - 0 9 3 5 3 - 7

SAMPLE DATE: YR. | MO. | DAY

NJ LAB CERT. NO.: 7 3 4 6 0

WCM USE

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0 8 8 8 (MO. YR.) TO 0 8 9 2 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

J	F	M	A	M	J	J	A	S	O	N	D	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
			X						X			Chrysene	ug/l	34320		
												Dibenzanthracene	ug/l	34556		
												1,2-Dichlorobenzene	ug/l	34536		
												1,3-Dichlorobenzene	ug/l	34566		
												1,4-Dichlorobenzene	ug/l	34571		
												3,3'-Dichlorobenzidine	ug/l	34631		
												Diethyl Phthalate	ug/l	34336		
												Dimethyl Phthalate	ug/l	34341		
												Di-n-butyl Phthalate	ug/l	39110		
												2,4-Dinitrotolulene	ug/l	34611		
												2,6-Dinitrotolulene	ug/l	34626		
												Di-n-octyl Phthalate	ug/l	34596		
												1,2-Diphenylhydrazine	ug/l	34346		
												Fluoranthene	ug/l	34376		
												Fluorene	ug/l	34381		
												Hexachlorobenzene	ug/l	39700		
												Hexachlorobutadiene	ug/l	34391		
												Hexachlorocyclopentadiene	ug/l	34386		
												Hexachloroethane	ug/l	34396		
												Indenopyrene	ug/l	34403		
												Isophorone	ug/l	34408		
												Naphthalene	ug/l	34696		
												Nitrobenzene	ug/l	34447		
												N-Nitrosodimethylamine	ug/l	34438		
												N-Nitrosodi-n-propylamine	ug/l	34428		
												N-Nitrosodiphenylamine	ug/l	34433		
												Phenanthrene	ug/l	34461		
												Pyrene	ug/l	34469		
												1,2,4-Trichlorobenzene	ug/l	34551		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ — SW ID NO: MW-16

LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	26-09353-7		73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Specific Conductance				
												Floating Product				
												Total Xylenes				

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form T-VWX-014
5/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

MONITORING REPORT — TRANSMITTAL SHEET

NJPDES NO. 0026077

REPORTING PERIOD (MO. YR.): 11 88 THRU 01 89

PERMITTEE:
Name: Unocal Chemical
Address: 1345 North Meacham Road
Schaumburg, IL 60196

FACILITY:
Name: Unocal Chemicals Division
Address: 350 Roosevelt Avenue
Carteret (County) Middlesex
Telephone: (201) 541- 4224

FORMS ATTACHED *(Indicate Quantity of Each)*

SLUDGE REPORTS - SANITARY
[ ] T-VWX-007 [ ] T-VWX-008 [ ] T-VWX-009

SLUDGE REPORTS - INDUSTRIAL
[ ] T-VWX-010A [ ] T-VWX-010B

WASTEWATER REPORTS
[ ] T-VWX-011 [ ] T-VWX-012 [ ] T-VWX-013

GROUNDWATER REPORTS
[1] VWX-015(A,B) [1] VWX-016 [1] VWX-017

NPDES DISCHARGE MONITORING REPORT
[ ] EPA FORM 3320-1

OPERATING EXCEPTIONS

	YES	NO
DYE TESTING	[ ]	[X]
TEMPORARY BYPASSING	[ ]	[X]
DISINFECTION INTERRUPTION	[ ]	[X]
MONITORING MALFUNCTIONS	[ ]	[X]
UNITS OUT OF OPERATION	[ ]	[X]
OTHER	[ ]	[X]

(Detail any "Yes" on reverse side in appropriate space.)

NOTE: The "Hours Attended at Plant" on the reverse of this sheet must also be completed.

AUTHENTICATION - I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inqui of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significa penalties for submitting false information including the possibility of fine and imprisonm

LICENSED OPERATOR

Name (Printed) ____
Grade & Registry No. ____
Signature ____
Date ____

PRINCIPAL EXECUTIVE OFFICER or DULY AUTHORIZED REPRESENTATIVE

Name (Printed): Daryl W. Dierwechter
Title (Printed): Supervisor Environmental Affairs
Signature ____
Date: March 21, 1989

OPERATING EXCEPTIONS DETAILED

HOURS ATTENDED AT PLANT

Month ☐☐ Year ☐☐

Day of Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Licensed Operator																
Others																
Day of Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Licensed Operator																
Others																

Form VWX-015 A
4/83

W JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GRO UND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical Carteret, NJ — SW ID NO: MW-17

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
R	NJ 0026077	- -	890207	73460	
1	2–8	9–16	17–22	23–27	28

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE
X			X			X			X			Elevation of top of well casing with cap off (as specified in well completion report)	feet MSL: to nearest .01		9.23
X			X			X			X			Elevation of original ground level (as specified in well completion report)	feet MSL: to nearest .01		9.63
X			X			X			X			Depth to water table from top of casing prior to sampling with cap off	feet: to nearest .01	82546	5.06
X			X			X			X			Depth to water table from original ground level prior to sampling	feet: to nearest .01	72019	5.46
			X									Arsenic, Dissolved	UG/L as As	01000	
												Barium, Dissolved	UG/L as Ba	01005	
												Biochemical Oxygen Demand - 5 Day	MG/L	00310	
												Cadmium, Dissolved	UG/L as Cd	01025	
X			X			X			X			Chloride, Dissolved	UG/L as Cl	82295	256400
												Chromium, Dissolved	UG/L as Cr	01030	
												Chromium, Dissolved, Hexavalent	UG/L as Cr	01220	
												Chemical Oxygen Demand (COD), Dissolved	MG/L	00341	
												Coliform Group	N/100 ML	74056	
												Color	Pt - Co	00080	
												Copper, Dissolved	UG/L as Cu	01040	
												Cyanide, Total	MG/L as CN	00720	
												Endrin, Total	UG/L	39390	
												Fluoride, Dissolved	MG/L as F	00950	
												Gross Alpha, Dissolved	Pc/L	01503	
												Gross Beta, Dissolved	Pc/L	03503	
												Hardness, Total as $CaCO_3$	MG/L	00900	
												Iron, Dissolved	UG/L as Fe	01046	
			X						X			Lead, Dissolved	UG/L as Pb	01049	
												Lindane, Total	UG/L	39782	
												Manganese, Dissolved	UG/L	01056	
			X									Mercury, Dissolved	UG/L	71890	

29 33 34 40 41
42 46 47 53 54
55 59 60 66 67
68 72 73 79 80

VALUE CODING RULES AND REMARK CODES ON REVERSE

Form VWX-015 B
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ

SW ID NO.: MW-17

LAB NAME: NANCO Laboratories, Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
S	NJ 0026077		890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
												Methoxychlor, Total	UG/L	39480		
												Methylene Blue Active Substances	MG/L	38260		
												Nitrogen, Ammonia, Dissolved $NH_3 + NH_4$ as N	MG/L as N	00608		
												Nitrogen, Nitrate Dissolved	MG/L as N	00618		
												Odor	T.O.N.	00085		
			X									pH	Standard Units	00400	6.96	
												Phenols, Total Recoverable	UG/L	32730		
												Radium 226, Dissolved	Pc/L	09503		
												Radium 228, Dissolved	Pc/L	81366		
												Selenium, Dissolved	UG/L	01145		
												Silver, Dissolved	UG/L	01075		
												Sodium, Dissolved	MG/L	00930		
			X									Sulfate, Dissolved (as SO_4)	MG/L	00946		
X			X			X			X			Total Dissolved Solids (TDS)	PPM	70300	726	
												Total Organic Carbon (TOC)	PPM	00680		
												Total Organic Halogen (TOX)	UG/L	70353		
												Toxaphene	UG/L	39400		
												Turbidity	NTU	00076		
			X									Zinc, Dissolved	UG/L	01090		
												2, 4—D, Total	UG/L	39370		
												2, 4, 5—TP, Total	UG/L	39045		

29 | 33 34 | 40 41
42 | 46 47 | 53 54
55 | 59 60 | 66 67
68 | 72 73 | 79 80

VALUE CODING RULES AND REMARK CODES ON REVERSE

Form VWX-016
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — VOLATILE ORGANICS REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME	SW ID NO.
UnocalChemical - Carteret, NJ	MW-17
LAB NAME	
NANCO Laboratories- Wappinger Falls, NY	

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	NCM USE
T	NJ 0026077	-	890207	73460	
1	2 – 8	9 – 16	17 – 22	23 – 27	28

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 0888 (MO. YR.) TO 0892 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Acrylonitrile	UG/L	34215	25	K
												Benzene	UG/L	34030	67	
												Bromoform	UG/L	32104	1.0	K
												Carbon Tetrachloride	UG/L	32102	1.0	K
												Chlorobenzene	UG/L	34301	1.0	K
												Chlorodibromoethane	UG/L	34306	1.0	K
												Chloroform	UG/L	32106	1.0	K
												1, 1 - Dichloroethane	UG/L	34496	9.0	
												1, 2 - Dichloroethane	UG/L	34531	1.0	K
												1, 1 - Dichloroethylene	UG/L	34501	1.0	K
												1, 2 - Dichloropropane	UG/L	34541	1.0	K
												Ethylbenzene	UG/L	34371	900	C
												Methylene Chloride	UG/L	34423	2.9	
												1, 1, 2, 2 - Tetrachloroethane	UG/L	34516	1.0	K
												Tetrachloroethylene	UG/L	34475	1.0	K
												Toluene	UG/L	34012	5.7	
												1, 1, 1 - Trichloroethane	UG/L	34506	1.0	K
												1, 1, 2 - Trichloroethane	UG/L	34511	1.0	K
												Trichloroethylene	UG/L	39180	1.0	K
												Vinyl Chloride	UG/L	39175	1.0	K
												Acrolein	UG/L	34210	25	K
												Chloroethane	UG/L	34311	1.0	K
												2 - Chloroethylvinyl Ether	UG/L	34576	1.0	K
												Dichlorobromomethane	UG/L	32105	1.0	K
												1, 3 - Dichloropropylene	UG/L	34699	1.0	K
												Methyl Bromide	UG/L	34413	1.0	K
												Methyl Chloride	UG/L	34418	1.0	K
												1, 2 - trans - Dichloroethylene	UG/L	34545	1.0	K
												1, 2 Dichlorobenzene	UG/L	34535	1.0	K
												1, 3 Dichlorobenzene	UG/L	34566	1.0	K
												1, 4 Dichlorobenzene	UG/L	34571	1.0	K

29 42 55 68 — 33 34 46 47 59 60 72 73 — 40 41 53 54 66 67 79 80

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017

P1

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemical - Carteret, NJ	SW ID NO. MW-17
LAB NAME: NANCO Laboratories - Wappingers Falls, NY	

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WCM USE
U	NJ 0026077	-	89 02 07	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS												ANALYTES	UNITS	PARAMETER	VALUE	REMARKS
			X						X			2-Chlorophenol	ug/1	34586		
												2,4-Dichlorophenol	ug/1	34601		
												2,4-Dimethylphenol	ug/1	34606		
												2,6-Dinitro-o-cresol	ug/1	77603		
												2,4-Dinitrophenol	ug/1	34616		
												2-Nitrophenol	ug/1	34591		
												4-Nitrophenol	ug/1	34649		
												p-Chloro-m-cresol	ug/1	34452		
												Pentachlorophenol	ug/1	39032		
												Phenol	ug/1	34695		
												2,4,6-Trichlorophenol	ug/1	34621		
												Acenaphthene	ug/1	34205		
												Acenaphthylene	ug/1	34200		
												Anthracene	ug/1	34220		
												Benzidine	ug/1	39120		
												Benzanthracene	ug/1	34526		
												Benzopyrene	ug/1	34247		
												3,4-Benzofluoranthene	ug/1	34230		
												Benzoperylene	ug/1	34521		
												Benzofluoranthene	ug/1	34242		
												Bis(2-chloroethoxy)methane	ug/1	34278		
												Bis(2-chloroethyl) Ether	ug/1	34273		
												Bis(2-chlroisopropyl) Ether	ug/1	34283		
												Bis(2-ethylhexyl) Phthalate	ug/1	39100		
												4-Bromophenyl Ether	ug/1	34636		
												Butylbenzyl Phthalate	ug/1	34292		
												2-Chloronaphthalene	ug/1	34581		
												4-Chlorophenyl Phenyl Ether	ug/1	34641		

VALUE CODING RULES AND

Form VWX-017
4/83

P2

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECT
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS – MONITORING WELL REPORT

ACID, BASE/NEUTRAL ORGANIC COMPOUNDS

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ	SW ID NO.: MW-17
LAB NAME: NANCO Laboratories - Wappingers Falls, NY	

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. / MO. / DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077		890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
			X						X			Chrysene	ug/l	34320		
												Dibenzanthracene	ug/l	34556		
												1,2-Dichlorobenzene	ug/l	34536		
												1,3-Dichlorobenzene	ug/l	34566		
												1,4-Dichlorobenzene	ug/l	34571		
												3,3'-Dichlorobenzidine	ug/l	34631		
												Diethyl Phthalate	ug/l	34336		
												Dimethyl Phthalate	ug/l	34341		
												Di-n-butyl Phthalate	ug/l	39110		
												2,4-Dinitrotolulene	ug/l	34611		
												2,6-Dinitrotolulene	ug/l	34626		
												Di-n-octyl Phthalate	ug/l	34596		
												1,2-Diphenylhydrazine	ug/l	34346		
												Fluoranthene	ug/l	34376		
												Fluorene	ug/l	34381		
												Hexachlorobenzene	ug/l	39700		
												Hexachlorobutadiene	ug/l	34391		
												Hexachlorocyclopentadiene	ug/l	34386		
												Hexachloroethane	ug/l	34396		
												Indenopyrene	ug/l	34403		
												Isophorone	ug/l	34408		
												Naphthalene	ug/l	34696		
												Nitrobenzene	ug/l	34447		
												N-Nitrosodimethylamine	ug/l	34438		
												N-Nitrosodi-n-propylamine	ug/l	34428		
												N-Nitrosodiphenylamine	ug/l	34433		
												Phenanthrene	ug/l	34461		
												Pyrene	ug/l	34469		
												1,2,4-Trichlorobenzene	ug/l	34551		

VALUE CODING RULES AND
REMARK CODES ON REVERSE

Form VWX-017
4/83

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
WATER QUALITY MANAGEMENT ELEMENT

GROUND WATER ANALYSIS — MONITORING WELL REPORT

PLEASE TYPE OR PRINT WITH BALLPOINT PEN

FACILITY NAME: Unocal Chemicals - Carteret, NJ
SW ID NO: MW-17
LAB NAME: NANCO Laboratories - Wappingers Falls, NY

	NJPDES NO.	WELL PERMIT NO.	SAMPLE DATE YR. | MO. | DAY	NJ LAB CERT. NO.	WQM USE
U	NJ 0026077	- -	890207	73460	

THE SCHEDULE INDICATED BELOW IS TO BE OBSERVED FROM 08 88 (MO. YR.) TO 08 92 (MO. YR.)

SUBMIT WITH SIGNED T-VWX-014

SAMPLING MONTHS

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANALYSIS	UNITS	PARAMETER	VALUE	REMARKS
X			X			X			X			Specific Conductance	mhos/cm		1207	
X			X			X			X			Floating Product	inches		0	
X			X			X			X			Total Xylenes	ug/l		29	K

VALUE CODING RULES AND
REMARK CODES ON REVERSE

REFERENCE NO. 10

NUS CORPORATION

TITLE: THREE MILE VICINITY MAP

SITE: UNION CHEMICAL CARTERET, N.J.

DATE: 06/07/89

TDD: 02-8804-89

QUAD: ARTHUR KILL, N.J.

FIGURE NUMBER:

SCALE: 1" = 2000'

REFERENCE NO. 11

FINAL REPORT
INITIAL SITE ASSESSMENT
UNION CHEMICALS SITE
CARTERET, NEW JERSEY

Prepared for:

UNION CHEMICALS DIVISION
PETRO CHEMICAL GROUP
UNION OIL COMPANY OF CALIFORNIA
SCHAUMBURG, ILLINOIS

NOVEMBER 25, 1985
PROJECT NO. 671030

Prepared by:

IT CORPORATION
PITTSBURGH, PENNSYLVANIA

ATTACHMENT
C

DRAFT REPORT

INITIAL SITE ASSESSMENT
UNION CHEMICALS SITE
CARTERET, NEW JERSEY

1.0 INTRODUCTION

IT Corporation (IT) was retained by Union Chemicals Division of Union Oil Company of California (Union Chemicals) to conduct a site assessment at their facility in Carteret, New Jersey (Figure 1). This site assessment followed Union Chemicals' request to IT in June 1985 for emergency response action to control the seepage of organic phase contaminants (product) into Noes Creek. The Union Chemicals site requires hydrogeologic and chemical data to both assess the existing in situ conditions at the site and to permit consideration of some remedial action alternatives designed to prevent further product seepage into Noes Creek. The objectives of this investigation are to characterize the following:

- Unconsolidated materials underlying the site
- Site hydrogeology, including the ground water flow direction and rate
- Extent and depth of existing subsurface contamination.

A preliminary site investigation was conducted during the emergency response action. This work entailed the excavation of five test pits and the collection of soil and water samples for chemical analysis. The information derived from this initial task was used to establish guidelines for the sampling and analysis program conducted as part of the site assessment.

This 4.4-acre (estimated) site was purchased from the Benjamin Moore Company in 1962 and current operations were started in 1963. The facility has been primarily used for bulk storage and repackaging since that time; however, from 1969 to 1984, anhydrous ammonia was processed to ammonia.

Approximately 125 different products are handled at the facility, mostly solvents. The general categories of chemicals include:

- o Aromatic hydrocarbons
- o Aliphatic hydrocarbons
- o Petrochemicals
  - Alcohol
  - Chlorinated solvents
  - Esters
  - Glycol
  - Glycol ether
  - Glycol ether esters
  - Ketones
  - Surfactants
  - Plasticizers
  - Silicones.

The site includes a packaging facility in the northern portion of the property, a driveway area and parking lot with a tank truck loading terminal, and an oil/water separator unit about 40 feet east of the terminal. The property is bounded by Noes Creek to the south, New Jersey Branch railroad tracks to the west, Roosevelt Avenue to the east, and the now or former Wheeler Condenser and Engineering Company to the north. An additional railroad track spur extends from the southwest to the northeast through the facility.

2.0 FIELD INVESTIGATION

2.1 EMERGENCY RESPONSE FIELD ACTIVITIES

Union Chemicals requested emergency response assistance on June 26, 1985 to contain product entering Noes Creek from a seep (Seep 1) south of the plant area (Figure 2). IT responded to their request to contain and collect seepage by placing a number of absorbent booms, both up- and downstream, across the creek, placing absorbent packs into sumps hand dug at the seep, and by excavating a suspect drain pipe found at the point of the seep. The excavation continued from the original point of the seep to just north of the concrete curb where a large pit was excavated. Product was observed seeping into this pit at several locations. A vacuum truck was used to collect the product and associated contaminated water which was then pumped into Union Chemicals storage tanks on site. Soil and water samples were collected from the area of the seep and analyzed for xylene, toluene, and benzene (Tables 1 and 2). A second seep was observed during these field activities approximately 60 feet east of the first seep (Figure 2). A sump was dug at the point of this seep and packed with absorbent material. The second seep prompted additional investigation to better define the existing problem.

Four test pits were excavated along the southern perimeter curb of the parking lot and driveway (Figure 2). During excavation of Test Pits 1, 2, and 3, product was observed seeping from the subsurface soil walls. One composite soil sample was collected from each of the four pits. Samples from Test Pits 2 and 4 were analyzed for volatile organics compounds (Table 2). A water sample was also collected from the bottom of the vacuum truck (Table 1). Soil classifications for these pits are presented in Appendix A.

The results of analyses from soil and water samples collected during the emergency response and additional investigation activities were used to design the work plan for the site assessment described in the following sections of this report.

2.2 DRILLING AND SOIL SAMPLING

Thirteen six-inch-outside-diameter soil borings were drilled to selected depths through surface fill and into natural subsurface soils (Figure 2). Soil samples were collected continuously from the borings using a two-inch-outside-diameter split-barrel sampler which was decontaminated between samples using detergent followed by clean rinse water. The sampler was driven ahead of the augers by a 140-pound hammer dropped 30 inches to provide Standard Penetration Test data (American Society for Testing and Materials [ASTM] Procedure D1586). Soil sample composites were collected from each two-foot interval starting at the ground surface. The soil samples were placed in clean, 500-milliliter, sealed amber glass jars. Two 40-milliliter volatile organic analysis (VOA) vials were also collected for each sample. Head space measurements for volatile organics were made from the jars with an organic vapor analyzer (OVA) to assist in characterizing soil contaminant levels (Table 3). All soil samples were shipped with appropriate chain-of-custody forms to the IT laboratory in Export, Pennsylvania for analysis and archiving. A log describing both the visual classification of the soils and drilling conditions was prepared by the IT field geologist (Appendix A). Drill cuttings and other wastes were drummed upon completion of each hole and properly disposed of later with other wastes derived from the initial emergency response activities at the Waste Conversion landfill.

2.3 MONITORING WELL INSTALLATION AND DEVELOPMENT

Monitoring wells were installed in 12 of the borings to allow ground water samples to be collected for chemical analysis and to provide water level information necessary to assess the direction and rate of ground water flow. The wells were constructed of two-inch-inside-diameter Schedule 40 stainless steel pipe with flush threads and 0.010-inch slotted stainless steel screens. A filter pack of coarse silica sand was placed in the annulus around each well screen and a bentonite seal was installed above the filter pack to impede the infiltration of surface water into the well. The remaining annulus between the borings and riser pipes was then grouted to ground surface with a mixture of cement and bentonite. A locking cap was installed on the riser pipe and eight-inch steel lamp hole covers were cemented in place around the riser pipe and set level with the ground surface. Well completion diagrams are presented in Appendix B.

The wells were developed by pumping with a diaphragm pump and flushing to remove fines from the area around the sensing zone to enhance communication between the water-bearing zone and the well. All water collected from the wells was placed in drums and later transferred to the Union Chemicals on-site storage tanks. All downhole well completion equipment was decontaminated between holes with hexane washes and distilled water rinses. The decontaminating fluids were collected and placed in the Union Chemicals on-site storage tanks.

2.4 MONITORING WELL ELEVATION AND LOCATION SURVEY

A survey was conducted of the installed monitoring wells by Goodman, Allgair, and Scott, a local, registered surveyor, to provide both vertical and horizontal control for water levels, samples, and geologic data. The Union Chemicals facility itself is surveyed horizontally to the New Jersey State Plane Coordinate System and vertically to the U.S. Geologic Survey elevations. Well locations and pertinent elevations are shown in Figure 2 and Table 4, respectively.

2.5 WATER LEVEL MEASUREMENT

Measurements of ground water levels in the monitoring wells were taken on three different dates and at five different times (Table 5). The water levels were obtained at varying times in an attempt to define ground water gradients at the site under varying tidal conditions. It was concluded, however, that proper evaluation of the tidal influence on the site ground water gradient would require installation and operation of several continuous water level recorders for a period of at least two weeks.

2.6 GROUND WATER SAMPLING AND ANALYSIS

Water samples were collected from each of the monitoring wells using a 1.05-inch-outside-diameter point source bailer. The samples were collected in order from the cleanest wells to those with the greatest accumulation of product. The sampling method was designed to determine whether or not volatile organic contaminants were stratified in the aquifer. Samples were collected separately from the top and bottom of the water column in Wells 5, 6, 8, 9, 10, and 11. Only the top of the water column was sampled in the remaining wells. The monitoring wells were not purged immediately prior to collecting samples to avoid disturbing any stratification of dissolved contaminants in the aquifer or the formation of free-phase product layers. Free-phase product was observed in Monitoring Wells 5, 6, and 8 at the top of the ground water table. Sample temperature, pH, and specific conductance were measured and recorded for each sample in the field. Ground water samples were placed in appropriate sealed containers with appropriate chemical preservatives and cooled to wet ice temperature (4 degrees Celsius) for delivery to the IT analytical laboratory. Chain-of-custody forms were completed and shipped with the samples. The bailer was decontaminated between wells with hexane and distilled water which was collected and placed in the Union Chemicals on-site storage tanks.

All samples were analyzed for volatile organic compounds. Samples from Wells 1, 5, 8, and 12 were analyzed for chloride, sulfate, and alkalinity. The results of all analyses are presented in Table 6.

2.7 HYDRAULIC CONDUCTIVITY TESTING

In situ rising head permeability tests were conducted in Monitoring Wells 1, 4, 6, 7, and 12 following ground water sampling to determine well sensitivity (degree of communication between the well and the water-bearing zone) and the hydraulic conductivity of the water-bearing zone. The tests were conducted by lowering the water level in the well below the ground water table and measuring the subsequent rise in water level as a function of time. The results of the permeability testing are presented in Table 7.

2.8 STREAM SEDIMENT SAMPLING

Two sediment samples were collected from Noes Creek (a low gradient tidally influenced stream); one from sediments upstream of the plant and the second from sediments downstream of the plant (Figure 2). The purpose of collecting these samples was to provide a preliminary determination of the plant's impact on Noes Creek sediments. The samples were collected with a hand trowel at the surface of the stream bottom sediments. Samples were placed in clean, amber glass jars and shipped to the IT laboratory for analysis. Results of the analysis are presented in Table 8.

3.0 RESULTS OF INVESTIGATION

3.1 SITE GEOLOGY AND HYDROGEOLOGY

The Union Chemicals facility is constructed on relatively level fill material emplaced on irregular, unconsolidated sedimentary deposits. Cross sections were constructed from the borings logs and are presented in Figures 3, 4, and 5. The locations and orientations of the sections are shown in Figure 2.

Fill deposits range in thickness from zero to at least 15 feet beneath the site and are composed of fine to coarse sands with some gravels, clay, bricks, concrete, metal, glass, and slag. Beneath the fill are irregular deposits of sands, clays, silty clays, silt, and peat. It appears that older sand and clay deposits have been partially eroded and the depressions filled in with younger deposits of peat, clays, and sands. This reworking of sediments was probably the result of meandering and ensizing by Noes Creek.

Ground water elevation data were collected at five different times and tidal stages (Table 5). The data show fluctuating water levels which may be associated with tidal changes. The total change in ground water level and lag time at each well due to tidal influence cannot be determined from the present data base. It may be necessary to install and operate several continuous ground water level recorders for a short time period to obtain the data required for evaluation of remedial action alternatives.

Generally, the ground water flows from north to south across the site (Figure 6). The water table contours were developed from the average of the last four water level measurements, excluding deeper Wells MW-7 and MW-2.

Water levels in two well groups, MW-1 and MW-2 and MW-6 and MW-7, show a downward ground water gradient in the sediments. The gradient is slight but consistent at these two sites. Actual vertical gradients may be greater beneath the site; the measured magnitude is likely reduced from actual conditions by the size of the sensing zone established by the long length of screen in the wells.

Permeability test results indicate that the fill, sand, and clay deposits have low to moderate hydraulic conductivities (Table 7).

Assuming an average ground water gradient of 5 feet/330 feet, an average hydraulic conductivity of 3×10^{-5} feet per second (9×10^{-4} centimeter per second), and a porosity of 0.4, the average ground water velocity was calculated to be about 1×10^{-6} feet per second, or about 32 feet per year. This value was calculated using the following equation:

$$V = \frac{ki}{\theta}$$

where

k = average hydraulic conductivity,

i = average horizontal ground water gradient perpendicular to the direction of ground water flow, and

θ = assumed representative porosity.

3.2 ANALYTICAL RESULTS

Elevated concentrations of volatile organics were detected in water and soil samples during the initial emergency response program (Tables 1 and 2). Additionally, free product was observed flowing into Test Pits 1 through 3 and at the water table in Monitoring Wells 5, 6, and 8. Water samples collected from seeps contained 8,200 parts per billion (ppb) benzene, 7,700 ppb toluene, and 100,000 ppb total xylenes. Soil samples collected from the area adjacent to the seep had a benzene concentration of 200 ppb and total xylenes of 440 ppb.

Table 2 also indicates the levels of volatile organics which were detected in soil samples from Test Pits 2 and 4. Test Pit 2 evidenced higher concentrations of all parameters analyzed than Test Pit 4, with the exception of ethylbenzene and total xylenes. The Test Pit 2 soil sample contained significant concentrations of:

- o Chlorobenzene
- o Methylene chloride
- o Tetrachloroethylene
- o 1,1,1-trichloroethane
- o Acetone
- o Total xylenes.

The Test Pit 4 soil sample contained significant concentrations of chlorobenzene and total xylenes.

During the drilling operations, head space measurements of volatile organics were conducted on soil samples which had been placed in glass jars. The results of the measurements indicate that organic materials are present throughout the sampled soil columns (Table 3). The type of OVA used for these determinations was of the ionization type so that methane gas, if present, did not influence the readings.

The ground water collected from the 12 monitoring wells was analyzed for all volatile priority pollutants and selected volatile nonpriority pollutants. Table 6 is a summary of pollutants detected in the water samples. The significant contaminants appearing on this list which have the potential for the greatest health risk are:

- o Benzene
- o Chlorobenzene
- o Methylene chloride
- o Tetrachloroethylene
- o Trans-1,2-dichloroethylene
- o 1,1,1-trichloroethane
- o Trichloroethylene.

Significant (greater than 100 ppb) concentrations of these contaminants were found in Monitoring Wells 4 through 11.

Volatile organics were not detected in the sediment samples collected from Noes Creek.

4.0 QUALITATIVE RISK ASSESSMENT

4.1 INTRODUCTION

A hydrogeologic investigation of the Union Chemicals site located in Carteret, New Jersey has indicated the presence of several volatile organic chemicals in the ground water beneath the facility. This qualitative risk assessment will provide a preliminary appraisal of the health risks and environmental impacts associated with exposure to those chemicals in site-specific circumstances.

The fundamental concept of the risk assessment stipulates the requirement of a hazard and an exposure to that hazard before a health risk or environmental impact can occur. A completed exposure pathway is inferred, which includes three necessary components: (1) a source--the presence of contaminants having known toxicological characteristics; (2) an exposure pathway--actual or potential pathways that are complete; and (3) receptors--human and environmental receptors in the exposure paths. The hydrogeologic study has established the presence of the hazardous constituents and provides preliminary data to evaluate the potential exposure pathways.

High levels of monocyclic aromatic hydrocarbons (benzene, chlorobenzene, ethylbenzene, toluene, and xylene) and halogenated aliphatic hydrocarbons (tetrachloroethylene, 1,1,1-trichloroethane, and vinyl chloride) were detected in site ground water and surface seepage samples. A nonaqueous phase liquid (NAPL) flow condition, evidenced by the presence of a product layer above the aqueous fraction of the seeps and ground water samples, was observed during the emergency response and hydrogeologic investigation phases of this project.

Based on the geographical and topographical distribution of potential human receptors and environmental biota, a preliminary estimate would indicate a low potential for human exposure and a high possibility of impacts on environmental biota, to the extent they are present in Noes Creek and the Arthur Kill.

C.10

4.2 CONTAMINATION CHARACTERIZATION

The contamination pattern of volatile organic constituents found on site can be characterized by the presence (or absence) and concentrations of selected indicator chemicals in the individual environmental media samples and by evaluation of the spatial distribution of contaminants.

Volatile organic contamination of ground water was chosen as the primary site investigation focus due to the following:

- The bulk of the materials handled at the facility and the materials known to have been released in the past or detected in ground water during the emergency response phase of the project are volatile organic compounds.
- Volatile organic compounds are generally highly mobile in soils due to high volatility (as indicated by vapor pressure), have high water solubility, and low capacity for soil adsorption (soil adsorption coefficient); therefore, permanent soil and sediment contamination by volatile organics should be minimal as compared to current levels of ground water contamination.

4.2.1 Probable Contaminant Source

High concentrations of volatile organic chemicals were found in the ground water and seeps (aqueous and nonaqueous fractions) collected at the site. The observed pattern of contamination and the resulting hypothesized sources depend to some extent on the placement of the monitoring well. This dependence results from the necessity to infer contamination patterns between the monitoring wells.

It appears that past spills and leakage has occurred from the tank farm located in the northwest section of the site. Monitoring Well 12 is an on-site upgradient well that has some utility as the background descriptor. Monitoring Wells 1 to 3 may also be monitoring background water quality, or are located outside of the contaminant plume. The ground water in these wells does not appear to be impacted at the present time. Major chemical constituents in the contaminated ground water plume emanating from the tank area are monocyclic aromatic hydrocarbons (MAHs). Indicator constituents in this category are benzene, chlorobenzene, ethylbenzene, toluene, and xylene.

Halogenated aliphatic hydrocarbon (HAHs) display a different distribution pattern among the analyzed samples and the location of the sampling points. They appear to have emanated from the tank farm in the center of the Union Chemicals facility. This is based on the absence of these particular contaminants in the ground water in the vicinity of the northwest tank farm. The HAHs selected as indicator chemicals for this site are tetrachloroethylene (PCE), 1,1,1-trichloroethane commonly known as methyl chloroform (MC), and vinyl chloride (VC) probably resulting from biodegradation of the PCE.

It must be emphasized that the above conclusions relating to the probable sources are based on limited background information and a small chemical analytical data base.

4.2.2 Characterization of Extent of Contamination

This description of the extent of contamination is intended to provide a framework for assessment of exposure to hazardous constituents migrating from the site. Since the chemical analytical data base is essentially limited to volatile organic contaminants detected in the ground water, the character of the other environmental media, i.e., ambient air (on and off site); soils (surficial and subsurface), in the unsaturated and saturated zone; surface water in Noes Creek and Arthur Kill; and creek sediments, cannot be directly evaluated. Appraisal of the likely extent of contamination of these environmental media is based on the limited background information and site investigation data available.

Ambient Air

The quality of on-site ambient air is unknown. However, the presence of volatile organics at relatively high concentrations in the ground water, the very shallow unsaturated zone above the ground water table which potentially provides a link between the air and ground water through capillary action, and contaminated seeps on site would indicate some impact on ambient air quality.

Volatile organic constituents are volatilizing from ground water, possibly contaminated soils (actual levels are unknown; high OVA readings were observed during soil disturbance when excavating the test pits) and contaminated surface waters of Noes Creek. The ambient air levels of benzene are probably elevated above background and could be at concentrations on the site that pose some risk upon exposure. All of the other contaminants, i.e., chlorobenzene, ethylbenzene, toluene, and xylene, will most likely also be elevated above background levels but are not expected to reach concentrations associated with health risks. None of the HAHs, although they will volatilize, are expected to be present above background levels. Vinyl chloride will evaporate readily at ambient temperatures, but detectable incremental elevations in concentrations are not likely due to the low levels detected in site ground water.

Undetermined semivolatile organics and inorganic constituents, if any, would not volatilize to the extent necessary to impact ambient air quality.

Soils

There is only a very limited chemical analytical data base available to estimate the extent of soil contamination. Based on the behavior of chemicals in the environment, the list of chemical products handled at this facility, and the presence of a NAPL flow condition, the following limited characterization may be applicable to this site:

- Presence and levels of volatile organic contaminants (found in the ground water) in the soils will be limited unless bulk dumping has occurred in the past or there is an ongoing contaminant release. Volatile organics are highly mobile in soils due to their ability to evaporate to air, high solubility in water, and low soil adsorption capability.

- Phthalate esters, polycyclic aromatic hydrocarbons (PAHs), and halogenated ethers may be present at significant levels in the soils in the unsaturated and saturated zones. The reported product mix and presence of a nonaqueous fraction (which is mainly organic solvents) would enhance the mobility of these relatively immobile chemicals in the soil and water media. However, there are no data available to determine the validity of this premise.

Ground Water

There appears to be both vertical and horizontal migration of the volatile organic constituents found in the ground water. This is likely due to the behavior of these particular chemicals in the environment. Vertical stratification of contaminants in some of the wells is apparent; lower specific gravity compounds were found in higher concentrations in samples taken from the top of the well. This may be due to gravity separation or could be due to a mixing of the NAPL solution in the upper sample.

The lighter MAHs appear to have migrated from the northwest tank area. The highest concentrations were found downgradient at this area in Monitoring Wells 6 and 8. Benzene and chlorobenzene were observed at the highest concentrations (benzene at 85,000 micrograms per liter [µg/ℓ] maximum; chlorobenzene at 230,000 µg/ℓ maximum) and with the highest frequency (15 positive detections in 16 samples). Only the MAHs (benzene, chlorobenzene, ethylbenzene, toluene, and xylene) and methyl chloroform have moved to the deeper part of the aquifer as indicated by the analytical results from the Monitoring Well 7 deep well sample.

The contaminant plume appears to be confined to a relatively limited area. Monitoring Wells 1 through 3 do not appear to be in the influence of the plume at this time.

Relative to potential exposure to contaminated ground water, it should be noted that:

- The dominant ground water flow direction is toward Noes Creek and Arthur Kill. This is away from the greatest concentration of human receptors located northwest of the site. Consequently, the potential for exposure to significant levels of volatile organic pollutants in ground water by ingestion is very low. This premise is valid whether the ground water is or is not being used for drinking purposes. There are, however, no known users of shallow ground water in the area of the site.
- Because there are no available data regarding semi-volatile organics that may be present in the ground water due to the NAPL conditions, the potential impacts due to ground water discharge to surface water cannot be evaluated.

Surface Water

There is a very limited available data base to characterize the contamination of surface water, i.e., Noes Creek and Arthur Kill. Seeps and ground water accumulated in the test pits are defined as ground water for the estimation of health risks and environmental impacts. Evaluation of surface water quality was not an objective of the first phase of the hydrogeological study.

A clear understanding of the environmental fate of the site contaminants is essential for estimating health and environmental impacts. The volatile organics in the ground water will be essentially volatilized at the surface water/ambient air interface. The most likely potential impacts on environmental and human receptors will be from migration of semivolatile organic pollutants in the nonaqueous fraction of contaminated ground water to both surface water and sediments. Semivolatiles that are solubilized in the nonaqueous phase could adsorb to colloidal particles in surface water and settle to the bottom in the sediments. There, they would be available to aquatic biota if biota are present. Some toxic constituents, i.e., PAHs, if they are present, could move up the food chain by bioaccumulation and biomagnification to result in significant potential exposure.

The extent of surface water contamination is unknown. Attenuation of volatile organic contaminants by evaporation and the unlikely possibility of impacted surface water being used as a potable water source (it may be brackish or sea water) may preclude exposure by human receptors. Transfer of volatile organics to ambient air is not expected to result in significant levels due to the great opportunities for attenuation by advection and dispersion in the open atmosphere.

4.3 EXPOSURE PATHWAYS

An exposure pathway is the route a contaminant may take to reach a susceptible receptor. For an exposure pathway to be complete, three factors must be present: a source of contamination, a route of contaminant transport, and an exposure of an environmental or human receptor to the contaminants. The mode of exposure and its duration also influence the impacts. Modes of exposure are usually categorized as inhalation, ingestion, and dermal (direct contact). There may be indirect exposures by ingestion of contaminated foods and by dermal and inhalation during recreational use (wading, fishing, and boating) of surface waters. Exposure durations are separated into two main classes, i.e., acute, which is of short duration and frequency, and chronic, which implies long-term (months and years) and continuous or frequent exposure.

4.3.1 Ambient Air

All of the detected contaminants are volatile organic constituents; consequently, all will evaporate at the soil/air and surface water/air interface to result in incremental increases in levels above background. The only potential exposure to toxicologically significant levels of the most critical contaminant (benzene) will be on site. Advection and dispersion would attenuate vapor concentrations to safe levels at the nearest off-site human receptor locations.

4.3.2 Soils

Surficial Soils

The relatively difficult access to the industrial area in which the site is located (the presence of a railroad track and perimeter fencing separating the residential area from this site) will minimize the trespass of children and third-party intruders. Consequently, only on-site personnel will be considered to be the potential receptors due to direct contact with or ingestion of contaminated surficial soils. Therefore, direct contact with contaminated surface soils is not considered to be a potential exposure path.

Subsurface Soils

Exposure to contaminants that may be present in the deep soils by direct contact is not expected to be a viable exposure pathway. Deep soils may serve as a conduit to transport volatile organics, and potentially semivolatile organics mobilized in the NAPL, to ground water.

Migration of volatile organics from the unsaturated zone to ambient air will elevate ambient air concentrations, but significant concentrations are not expected on site and are very unlikely at any off-site receptor location.

4.3.3 Ground Water

Ingestion of contaminated ground water is not expected to be a critical exposure path at this site. All of the ground water beneath the site is flowing away from the closest cluster of homes (supplied by a city water system). Ground water discharges from the site into Noes Creek very rapidly reach Arthur Kill . Both bodies of water are subject to salt water intrusion making local surface water an unavailable source of potable water for the nearby residents.

Indirect exposure to some contaminants, if the volatile organics are not attenuated, during recreational use of Arthur Kill is possible. However, the industrial character of the surrounding area and the presence of a large active landfill and marsh on the Staten Island side of the Kill would deter recreational use of the surface water in the impacted area.

4.3.4 Surface Water

Surface waters may be impacted. There are no available data to determine whether volatile organic contaminant attenuation is occurring. If semivolatile organic constituents are entering the Creek and Kill they would accumulate in the bottom sediment. Consequently, there could be some potential for uptake in the food chain with subsequent exposure of human receptors due to ingesting contaminated aquatic food. The volatile organics do not bioaccumulate to any great extent. The most likely exposure path would be associated with semivolatiles that may be mobilized in the NAPL and transported by ground water discharges and surface seeps to Noes Creek.

4.3.5 Environmental Impacts

The most toxic class of contaminants in the context of aquatic toxicity is the inorganic constituents. This does not appear to be a problem at this site. The low conductivity of the ground water samples is indicative of low dissolved solids and an absence of ionic activity in the water. Volatile organics will be attenuated due to evaporation of the surface water/air interface. In addition, most of them are not acutely or chronically toxic to aquatic biota at the expected surface water concentrations. The introduction of pollutants from the landfill that have high associated biological and chemical oxygen demand may affect the dissolved oxygen levels in the creek and Arthur Kill to result in adverse effects on the aquatic biota (if they are present).

4.4 RECEPTORS

The following potential human receptors may be present in the vicinity of the site:

- Users of ground water for drinking purposes - None known in the area surrounding the site

- Users of surface water for recreational purposes - Dermal exposure during swimming and boating (inadvertent dermal exposure) and inhalation of volatilized organics

- Persons trespassing on site and coming in direct contact (dermal exposure) with contaminated soils and ground water (seeps) on site

- Persons coming in contact with contaminated sediment and surface soils that may have migrated off site in surface runoff

- Persons inhaling volatilized organic vapors that are mobilized by wind erosion

- Persons consuming contaminated aquatic food that has bioaccumulated and biomagnified contaminant levels.

Environmental receptors include:

- Aquatic biota that are exposed to organic contaminants with associated bioaccumulation and biomagnification characteristics

- Surface waters that may be adversely affected to limit their use for any purpose

- Wetland and marsh ecologies that are very fragile and will be adversely altered by introduction of chemical contaminants.

The identification and characterization of the above receptors was not an objective of the first phase of this investigation. Based on the topographical and geographical character of the site and the surrounding area, as interpreted from the USGS map, the presence of the above receptors at locations where significant impacts may be possible is not a high probability at present or at some future time.

4.5 HAZARD IDENTIFICATION

The identification and characterization of hazards associated with the site is based on the presence and concentration of chemicals found. Consequently, this hazard characterization is based on volatile organic compounds detected in the ground water beneath the site.

The following criteria are used to select the indicator contaminants for the risk assessment:

- Toxicity - If the contaminant has associated biological health impacts, i.e., carcinogenicity or development effects, it should be included as a contaminant of concern. Acute and chronic systemic toxicity has an implied threshold level; consequently, other criteria must be used in conjunction with toxicity.
- Concentration levels - Constituents detected at high concentrations in the environmental media should be included if they are prevalent.
- Prevalence is defined by the frequency of positive detections in the collected samples and the character of the contamination pattern.
- Persistence in the environment.

Table 9 provides a summary of the pertinent factors for categorizing the detected contaminants.

Benzene, vinyl chloride, and PCE are classified as suspect animal or human carcinogens. They were found frequently, especially benzene, in the ground water samples at significant concentrations. Consequently, all were included as indicator contaminants.

Ethylbenzene, toluene, methyl chloroform, and xylene, which have exhibited systemic toxicity with associated thresholds, were detected frequently to indicate a high prevalence in the ground water. They were selected as indicator contaminants for the risk assessment.

Chlorobenzene was classified as an indicator chemical due to the very high concentrations found on site. Since it does not possess any toxicological properties, it was considered to be a precursor of benzene and xylene and was used to define the extent of contamination.

Although chloroethane was frequently detected in the ground water samples and the maximum concentration of 1,600 ug/ℓ was considered to be an anomaly (the next highest value was 67 ug/ℓ) the concentrations are not considered to be significant. This evaluation is based on the low toxicity of this compound by the ingestion route and its chemical nature, i.e., it is a gas at normal temperatures. 1,1-dichloroethane and 1,2-trans-dichloroethylene were also detected frequently. However, at the concentrations measured exposure is not likely to cause a health impact.

Ketones (acetone, 2-butanone [methylethyl ketone]) and styrene were found less frequently. However, at the reported concentrations, exposure is not expected to result in any adverse health impacts due to the relatively low systemic toxicity of these compounds.

4.6 EXPOSURE ASSESSMENT

As explained in the previous sections, there is no existing exposure of receptors to the site contaminants due to hydrological and geographical factors. Vapors and airborne particulates are not expected to reach off-site human receptors in signifianct conentrations. Additionally, the population in close proximity to the site is served by a municipal water system and the direction of contaminated ground water migration is directly away from the closest off-site human receptors. Thus, they are not located in potential exposure pathways. Ambient air and ground water contaminant concentrations will be reduced to insignificant levels by the time they reach the nearest downwind and downgradient human receptor.

If sensitive ecological systems are in the exposure pathway, i.e., marsh and wetland habitats, there could be some potential degradation or alteration of the biotic communities.

Presence or absence of environmentally persistent contaminants has not been established. The above exposure assessment is based only on the available chemical analytical data, hydrological data developed in this phase of the investigation, and an interpretation of the U.S. Geological Survey topographic map of the area.

4.7 RISK CHARACTERIZATION

Due to hydrological and topographical factors, and spatial distribution of possible receptors, the site does not appear to pose any health risks. There is some potential for environmental impacts on aquatic and terrestrial biota if fragile ecological habitats are located in the area.

TABLE 4

MONITORING WELL ELEVATIONS(a)

MONITORING WELL	TOP OF COVER	TOP OF INSIDE PIPE	BOTTOM OF WELL
MW-1	8.98	8.27	-1.02
MW-2	8.47	7.91	-21.53
MW-3	9.31	8.87	-4.69
MW-4	9.30	8.68	1.30
MW-5	9.16	8.90	1.16
MW-6	8.84	8.60	-7.16
MW-7	8.83	8.24	-23.17
MW-8	9.43	8.82	4.57
MW-9	10.40	9.89	-4.60
MW-10	10.83	10.32	2.83
MW-11	11.25	10.70	3.25
MW-12	12.48	12.10	4.48

(a)Elevations in feet (msl).

TABLE 5

GROUND WATER ELEVATIONS

MONITORING WELL NO.	DATE/APPROXIMATE TIME				
	9-17-85/07:50(a)	9-17-85/14:20(b)	10-7-85/10:00(c)	10-7-85/16:15(d)	10-15-85/12:30(e)
1	2.69	3.10	4.52	2.52	4.89
2	3.45	3.33	4.16	2.16	4.78
3	5.45	6.24	6.54	5.87	6.56
4	5.51	5.91	6.35	6.18	6.90
5	3.15	3.65	3.57	3.40	4.80
6	3.60	4.18	4.45	3.10	4.83
7	2.86	3.16	4.16	3.24	4.70
8	4.53	5.49	5.66	5.03	5.02
9	7.39	7.89	8.31	8.16	8.46
10	6.07	8.11	8.57	8.69	8.77
11	8.20	9.20	9.91	9.89	9.47
12	8.60	9.93	10.93	10.89	10.44

(a)High tide at Sandy Hook, NJ 9-17-85 was at 09:24.

(b)Low tide at Sandy Hook, NJ 9-17-85 was at 16:00.

(c)High tide at Sandy Hook,NJ 10-7-85 was at 13:11.

(d)Low tide at Sandy Hook, NJ 10-7-85 was at 20:18.

(e)Low tide at Sandy Hook, NJ 10-15-85 was at 14:38.

Note: All elevations in feet (msl).

TABLE 6

GROUND WATER ANALYSES SUMMARY

PARAMETER	MW-1T	MW-2T	MW-3T	MW-4T	MW-5T	MW-6B	MW-6T	MW-7T	MW-8B	MW-8T	MW-9B	MW-9T	MW-10B	MW-10T	MW-11B	MW-11T	MW-12T
	SAMPLE IDENTIFICATION																
Volatile Priority Pollutants (ppb)																	
Benzene	7.3	22	22	2,200	2,500	49,000	85,000	320	17,000	18,000	2,800	2,300	120	61	240	240	-
Chlorobenzene	17	150	41	4,200	23,000	230,000	150,000	2,000	140,000	130,000	1,500	230	13	-	310	300	16
Chlorodibromomethane	-	-	-	-	-	-	-	2.7	-	-	-	-	-	-	-	-	-
Chloroethane	-	6.8	25	1,600	55	-	4.1	-	-	-	65	67	47	38	6.6	5.9	-
Chloroform	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-
1,1 Dichloroethane	2.5	46	4.2	120	12	-	2.5	-	5.6	4.1	7.7	6.0	-	-	-	-	1.1
1,2 Dichloroethane	-	-	-	9.9	3.7	-	-	2.4	-	-	-	-	-	-	1.1	-	-
1,1 Dichloroethylene	-	8.6	-	-	-	-	-	-	1.7	1.4	-	-	-	-	-	-	-
1,3 Dichloroethylene	-	-	-	64	-	-	-	-	-	-	79	37	-	-	6.2	6.0	-
Ethylbenzene	-	-	-	280	2,700	-	2,600	230	1,400	1,800	300	44	480	-	-	-	-
Methylene Chloride	-	-	-	-	-	630	21	-	14	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	-	-	-	-	15	-	-	-	-	-	-	-	-	-	7.2	-	1.9
Tetrachloroethylene	-	1.0	-	2.8	-	200	120	-	940	1,100	-	-	-	-	-	-	-
Toluene	1.0	6.6	-	2,800	570	2,700	5,200	37	990	580	18	-	220	2.1	3.0	1.8	-
Trans-1,2 Dichloroethylene	-	2.8	1.3	62	1.0	640	76	2.4	280	220	4.6	-	-	-	-	-	1.4
1,1,1-Trichloroethane	-	87	55	44	-	-	4.1	450	330	280	15	110	-	-	-	-	-
Trichloroethylene	-	2.2	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-
Vinyl Chloride	-	-	-	15	-	-	10	-	49	60	-	10	-	-	-	-	-
Volatile Non Priority Pollutants (ppb)																	
Acetone	-	-	-	16	28	-	-	65	22	12	17	-	-	-	-	-	-
2-Butanone	-	-	-	-	100	-	-	62	89	-	78	100	-	-	-	-	-
Carbon disulfide	13	18	-	46	-	-	-	-	-	-	-	-	48	18	-	48	28
4-Methyl-2-pentanone	-	-	-	26	-	-	-	-	-	-	-	-	-	-	-	-	-
Styrene	-	-	-	7.6	39	-	250	-	210	180	45	-	110	-	-	-	-
Xylenes, Total	-	-	-	920	4,500	2,200	24,000	890	750	620	1,500	250	10,000	540	-	-	-
Other Parameters (ppm)																	
Total Organic Carbon	16	6	82	23	28	48	30	13	23	18	26	24	13	12	8	7	4
Total Organic Halogen	0.38	0.15	0.16	1.5	13	73	26	3.1	40	36	0.94	2.2	0.44	0.64	0.46	0.85	0.26
Alkalinity	460				380				530/550	510							270
Chloride	180				290				220/220	210							13
Sulfate	60				3				4	3							15
Field pH	6.0	6.6	6.7	6.6	6.5	6.6	6.5	6.8	6.6	6.8	6.7	6.6	6.6	6.5	6.5	6.4	6.3
Field Specific Conductance (umhos/cm @ 25°C)	470	310	590	440	1500	220	1600	480	510	500	500	505	330	340	220	220	150
Field Temperature(°C)	23	23	25	26	23	22	25	23	21	24	22	29	23	23	24	25	23

C26

TABLE 8

STREAM SEDIMENT ANALYSES SUMMARY

PARAMETER	SAMPLE IDENTIFICATION	
Volatile Priority Pollutants	NC-D	NC-U
(ppb)		
	None Detected	
Volatile Non Priority Pollutants		
(ppb)		
	None Detected	
Other Parameters		
(ppm)		
Total Organic Carbon	3500	3300
Total Organic Halogen	0.40/0.46	0.74

REFERENCE NO. 12

Uncontrolled Hazardous Waste Site Ranking System

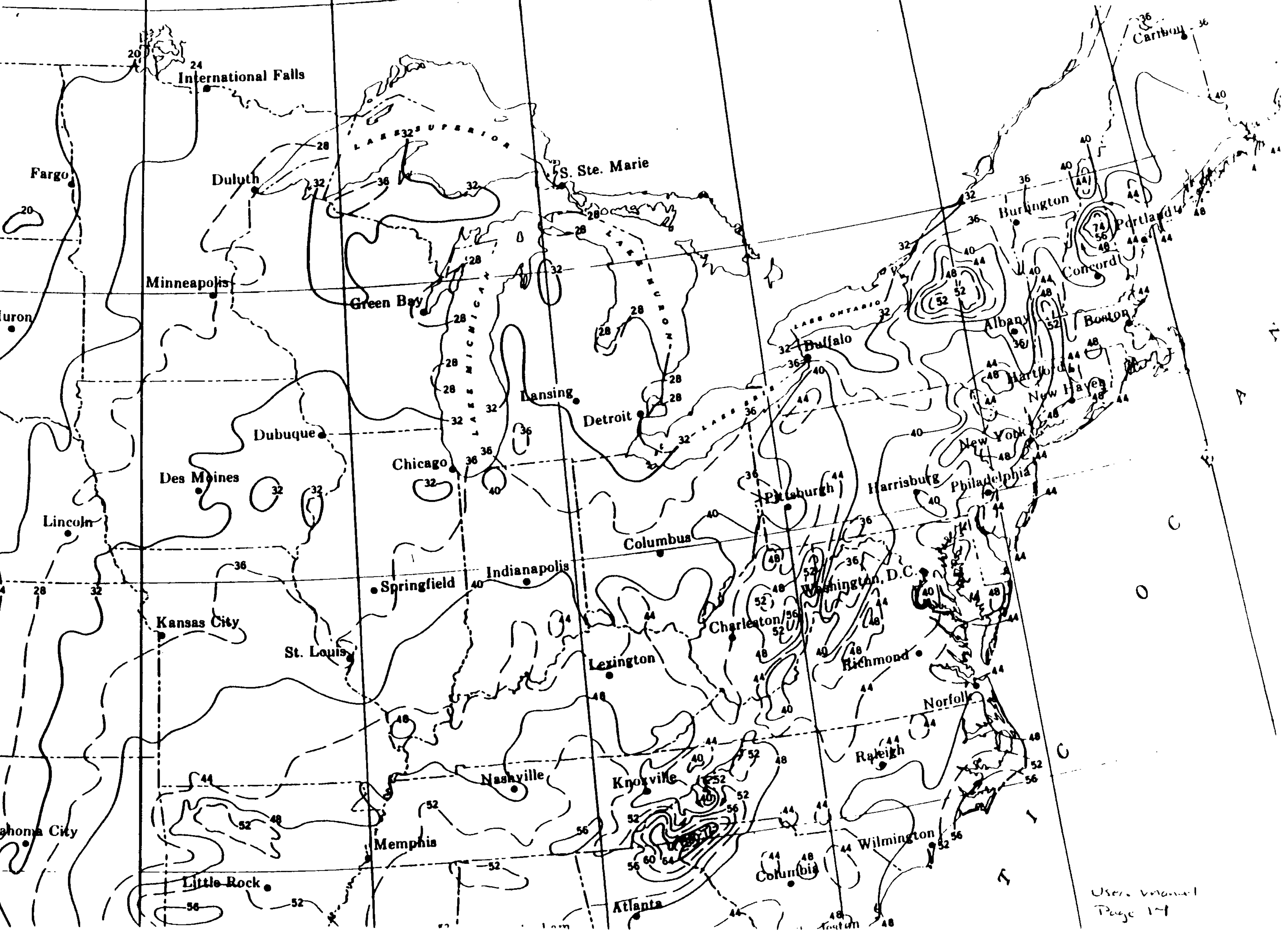
A Users Manual
(HW-10)

Originally Published in
the July 16, 1982, *Federal Register*

United States
Environmental Protection
Agency

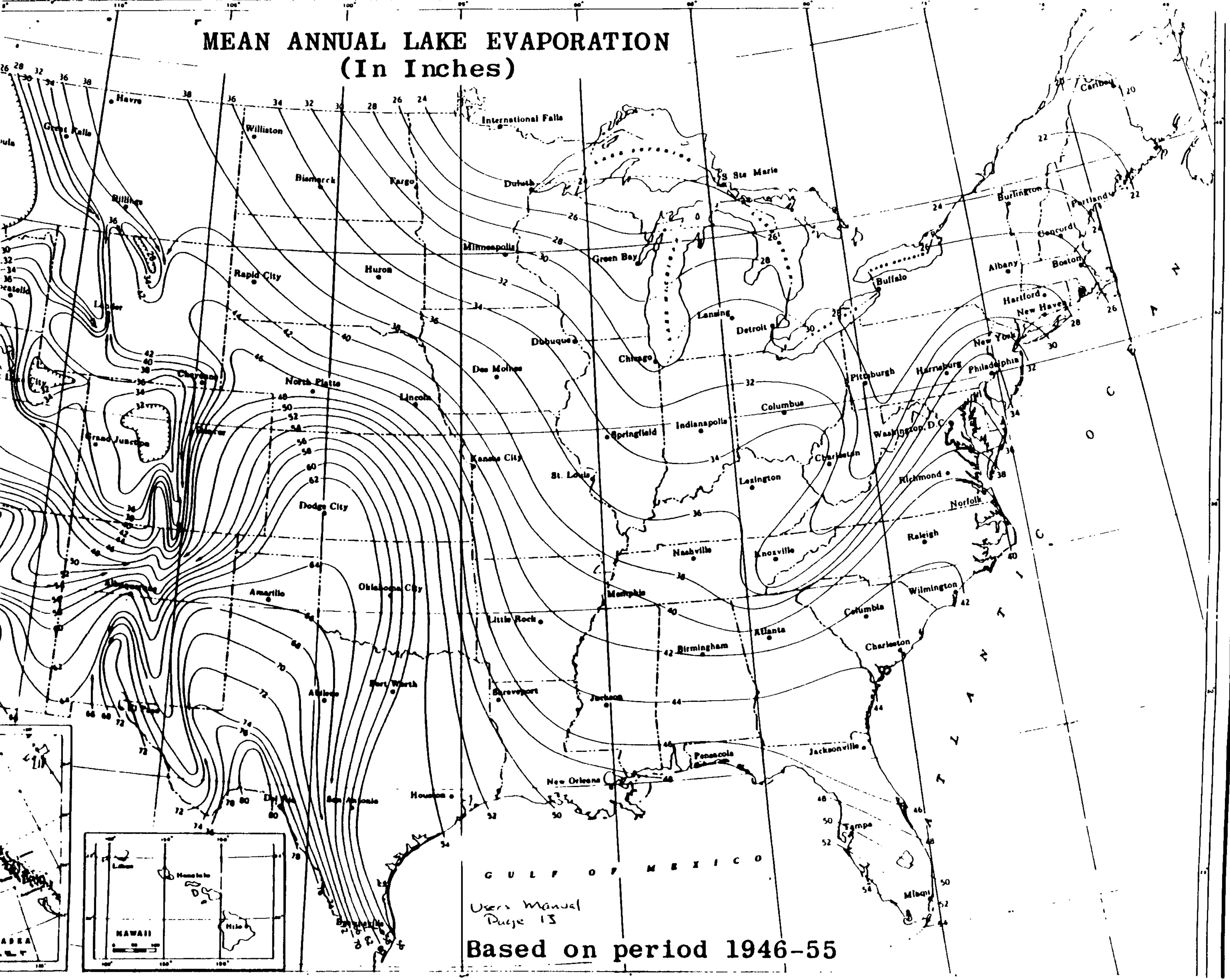
1984

NORMAL ANNUAL TOTAL PRECIPITATION (Inches)



Users Manual
Page 14

MEAN ANNUAL LAKE EVAPORATION
(In Inches)



Users Manual
Page 13

Based on period 1946-55

TABLE 2

PERMEABILITY OF GEOLOGIC MATERIALS*

Type of Material	Approximate Range of Hydraulic Conductivity	Assigned Value
Clay, compact till, shale; unfractured metamorphic and igneous rocks	$<10^{-7}$ cm/sec	0
Silt, loess, silty clays, silty loams, clay loams; less permeable limestone, dolomites, and sandstone; moderately permeable till	10^{-5} - 10^{-7} cm/sec	1
Fine sand and silty sand; sandy loams; loamy sands; moderately permeable limestone, dolomites, and sandstone (no karst); moderately fractured igneous and metamorphic rocks, some coarse till	10^{-3} - 10^{-5} cm/sec	2
Gravel, sand; highly fractured igneous and metamorphic rocks; permeable basalt and lavas; karst limestone and dolomite	$>10^{-3}$ cm/sec	3

*Derived from:

Davis, S. N., Porosity and Permeability of Natural Materials in Flow-Through Porous Media, R.J.M. DeWest ed., Academic Press, New York, 1969

Freeze, R.A. and J.A. Cherry, Groundwater, Prentice-Hall, Inc., New York, 1979

TABLE 3

CONTAINMENT VALUE FOR GROUND WATER ROUTE

Assign containment a value of 0 if: (1) all the hazardous substances at the facility are underlain by an essentially non permeable surface (natural or artificial) and adequate leachate collection systems and diversion systems are present; or (2) there is no ground water in the vicinity. The value "0" does not indicate no risk. Rather, it indicates a significantly lower relative risk when compared with more serious sites on a national level. Otherwise, evaluate the containment for each of the different means of storage or disposal at the facility using the following guidance.

A. Surface Impoundment

	Assigned Value
Sound run-on diversion structure, essentially non permeable liner (natural or artificial) compatible with the waste, and adequate leachate collection system	0
Essentially non permeable compatible liner with no leachate collection system; or inadequate freeboard	1
Potentially unsound run-on diversion structure; or moderately permeable compatible liner	2
Unsound run-on diversion structure; no liner; or incompatible liner	3

B. Containers

	Assigned Value
Containers sealed and in sound condition, adequate liner, and adequate leachate collection system	0
Containers sealed and in sound condition, no liner or moderately permeable liner	1
Containers leaking, moderately permeable liner	2
Containers leaking and no liner or incompatible liner	3

C. Piles

	Assigned Value
Piles uncovered and waste stabilized; or piles covered, waste unstabilized, and essentially non permeable liner	0
Piles uncovered, waste unstablized, moderately permeable liner, and leachate collection system	1
Piles uncovered, waste unstabilized, moderately permeable liner, and no leachate collection system	2
Piles uncovered, waste unstablized, and no liner	3

D. Landfill

	Assigned Value
Essentially non permeable liner, liner compatible with waste, and adequate leachate collection system	0
Essentially non permeable compatible liner, no leachate collection system, and landfill surface precludes ponding	1
Moderately permeable, compatible liner, and landfill surface precludes ponding	2
No liner or incompatible liner; moderately permeable compatible liner; landfill surface encourages ponding; no run-on control	3

more specific information is given in Tables 4 and 5.

Toxicity of each hazardous substance being evaluated is given a value using the rating scheme of Sax (Table 6) or the National Fire Protection Association (NFPA) (Table 7) and the following guidance:

Toxicity	Assigned Value
Sax level 0 or NFPA level 0	0
Sax level 1 or NFPA level 1	1
Sax level 2 or NFPA level 2	2
Sax level 3 or NFPA level 3 or 4	3

Table 4 presents values for some common compounds.

Hazardous waste quantity includes all hazardous substances at a facility (as received) except that with a containment value of 0. Do not include amounts of contaminated soil or water; in such cases, the amount of contaminating hazardous substance may be estimated.

On occasion, it may be necessary to convert data to a common unit to combine them. In such cases, 1 ton = 1 cubic yard = 4 drums and for the purposes of converting bulk storage, 1 drum = 50 gallons. Assign a value as follows:

Tons/Cubic Yards	No. of Drums	Assigned Value
0	0	0
1-10	1-40	1
11-62	41-250	2
63-125	251-500	3
126-250	501-1000	4
251-625	1001-2500	5
626-1250	2501-5000	6
1251-2500	5001-10,000	7
>2500	>10,000	8

TABLE 4
WASTE CHARACTERISTICS VALUES FOR SOME COMMON CHEMICALS

CHEMICAL/COMPOUND	TOXICITY [1]	PERSISTENCE [2]	IGNITABILITY [3]	REACTIVITY [3]
Acetaldehyde	3	0	3	2
Acetic Acid	3	0	2	1
Acetone	2	0	3	0
Aldrin	3	3	1	0
Ammonia, Anhydrous	3	0	1	0
Aniline	3	1	2	0
Benzene	3	1	3	0
Carbon Tetrachloride	3	3	0	0
Chlordane	3	3	0*	0*
Chlorobenzene	2	2	3	0
Chloroform	3	3	0	0
Cresol-O	3	1	2	0
Cresol-M&P	3	1	1	0
Cyclohexane	2	2	3	0
Endrin	3	3	1	0
Ethyl Benzene	2	1	3	0
Formaldehyde	3	0	2	0
Formic Acid	3	0	2	0
Hydrochloric Acid	3	0	0	0
Isopropyl Ether	3	1	3	1
Lindane	3	3	1	0
Methane	1	1	3	0
Methyl Ethyl Ketone	2	0	3	0
Methyl Parathion in Xylene Solution	3	0Δ	3	2
Naphthalene	2	1	2	0
Nitric Acid	3	0	0	0
Parathion	3	0Δ	1	2
PCB	3	3	0Δ	0Δ
Petroleum, Kerosene (Fuel Oil No. 1)	3	1	2	0
Phenol	3	1	2	0
Sulfuric Acid	3	0	0	2
Toluene	2	1	3	0
Trichlorobenzene	2	3	1	0
α-Trichloroethane	2	2	1	0
Xylene	2	1	3	0

[1] Sax, N. I., Dangerous Properties of Industrial Materials, Van Nostrand Rheinhold Co., New York, 4th ed., 1975. The highest rating listed under each chemical is used.

[2] JRB Associates, Inc., Methodology for Rating the Hazard Potential of Waste Disposal Sites, May 5, 1980.

[3] National Fire Protection Association, National Fire Codes, Vol. 13, No. 49, 1977.

* Professional judgment based on information contained in the U.S. Coast Guard CHRIS Hazardous Chemical Data, 1978.

Δ Professional judgment based on existing literature.

TABLE 5

PERSISTENCE (BIODEGRADABILITY) OF SOME ORGANIC COMPOUNDS*

VALUE = 3 HIGHLY PERSISTENT COMPOUNDS	
aldrin	heptachlor
benzopyrene	heptachlor epoxide
benzothiazole	1,2,3,4,5,7,7-heptachloronorbornene
benzothiophene	hexachlorobenzene
benzyl butyl phthalate	hexachloro-1,3-butadiene
bromochlorobenzene	hexachlorocyclohexane
bromoform butanal	hexachloroethane
bromophenyl phyntl ether	methyl benzothiazole
chlordane	pentachlorobiphenyl
chlorohydroxy benzephenone	pentachlorophenol
bis-chloroisoprophyl ether	1,1,3,3-tetrachloroacetone
m-chloronitrobenzene	tetrachlorobiphenyl
DDE	thiomethylbenzothiazole
DDT	trichlorobenzene
dibromobenzene	trichlorobiphenyl
dibutyl phthalate	trichlorofluoromethane
1, 4-dichlorobenzene	2,4,6-trichlorophenol
dichlorodifluoroethane	triphenyl phosphate
dieldrin	bromodichloromethane
diethyl phthalate	bromoform
di(2-ethylhexyl)phthalate	carbon tetrachloride
dihexyl phthalate	chloroform
di-isobutyl phthalate	chloromochloromethane
dimethyl phthalate	dibromodichloroethane
4,6-dinitro-2-aminophenol	tetrachloroethane
dipropyl phthalate	1,1,2-trichloroethane
endrin	

VALUE = 1 SOMEWHAT PERSISTENT COMPOUNDS	
acetylene dichloride	limonene
behenic acid, methyl ester	methyl ester of lignoceric acid
benzene	methane
benzene sulfonic acid	2-methyl-5-ethyl-pyridine
butyl benzene	methyl naphthalene
butyl bromide	methyl palmitate
e-caprolactam	methyl phenyl carbinol
carbon-disulfide	methyl stearate
o-cresol	naphthalene
decane	nonane
1,2-dichloroethane	octane
1,2-dimethoxy benzene	octyl chloride
1,3-dimethyl naphthalene	pentane
1,4-dimethyl phenol	phenyl benzoate
dioctyl adipate	phthalic anhydride
n-dodecane	propylbenzene
ethyl benzene	1-terpineol
2-ethyl-n-hexane	toluene
o-ethyltoluene	vinyl benzene
isodecane	xylene
isoprophyl benzene	

VALUE = 2 PERSISTENT COMPOUNDS	
acenaphthylene	cis-2-ethyl-4-methyl-1,3-dioxolane
atrazine	trans-2-ethyl-4-methyl-1,3-dioxolane
(diethyl) atrazine	guaiacol
barbital	2-hydroxyadiponitrile
borneol	isophorone
bromobenzene	indene
camphor	isoborneol
chlorobenzene	isopropenyl-r-isopropyl benzene
1,2-bis-chloroethoxy ethane	2-methoxy biphenyl
b-chloroethyl methyl ether	methyl biphenyl
chloromethyl ether	methyl chloride
chloromethyl ethyl ether	methylindene
3-chloropyridine	methylene chloride
di-t-butyl-p-benzoquinone	nitroanisole
dichloroethyl ether	nitrobenzene
dihyrocarvone	1,1,2-trichloroethylene
dimethyl sulfoxide	trimethyl-trioxo-hexahydro-triazine isomer
2,6-dinitrotoluene	

VALUE = 0 NONPERSISTENT COMPOUNDS	
acetaldehyde	methyl benzoate
acetic acid	3-methyl butanol
acetone	methyl ethyl ketone
acetophenone	2-methylpropanol
benzoic acid	octadecane
di-isobutyl carbinol	pentadecane
docosane	pentanol
eicosane	propanol
ethanol	propylamine
ethylamine	tetradecane
hexadecane	n-tridecane
methanol	n-undecane

TABLE 6

SAX TOXICITY RATINGS

0 - No Toxicity* (None)**

This designation is given to materials which fall into one of the following categories:

(a) Materials which cause no harm under any conditions of normal use.

(b) Materials which produce toxic effects on humans only under the most unusual conditions or by overwhelming dosage.

1 - Slight Toxicity* (Low)**

(a) *Acute local.* Materials which on single exposures lasting seconds, minutes, or hours cause only slight effects on the skin or mucuous membranes regardless of the extent of the exposure.

(b) *Acute systemic.* Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and which produce only slight effects following single exposures lasting seconds, minutes, or hours, or following ingestion of a single dose, regardless of the quantity absorbed or the extent of exposure.

(c) *Chronic local.* Materials which on continuous or repeated exposures extending over periods of days, months, or years cause only slight and usually reversible harm to the skin or mucous membranes. The extent of exposure may be great or small.

(d) *Chronic systemic.* Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and which produce only slightly usually reversible effects extending over days, months, or years. The extent of the exposure may be great or small.

In general, those substances classified as having "slight toxicity" produce changes in the human body which are readily reversible and which will disappear following termination of exposure, either with or without medical treatment.

2 - Moderate Toxicity* (Mod)**

(a) *Acute local.* Materials which on single exposure lasting seconds, minutes, or hours cause moderate effects on the skin or mucous membranes. These effects may be the result of intense exposure for a matter or seconds or moderate exposure for a matter of hours.

(b) *Acute systemic.* Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and produce moderate effects following single exposures lasting seconds, minutes, or hours, or following ingestion of a single dose.

(c) *Chronic local.* Materials which on continuous or repeated exposures extending over periods of days, months, or years cause moderate harm to the skin or mucous membranes.

(d) *Chronic systemic.* Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and which produce moderate effects following continuous or repeated exposures extending over periods of days, months, or years.

Those substances classified as having "moderate toxicity" may produce irreversible as well as reversible changes in the human body. These changes are not of such severity as to threaten life or to produce serious physical impairment.

3 - Severe Toxicity* (High)**

(a) *Acute local.* Materials which on single exposure lasting seconds or minutes cause injury to skin or mucous membranes or sufficient severity to threaten life or to cause permanent physical impairment or disfigurement.

(b) *Acute systemic.* Materials which can be absorbed into the body by inhalation, ingestion, or through the skin and which can cause injury of sufficient severity to threaten life following a single exposure lasting seconds, minutes, or hours, or following ingestion of a single dose.

(c) *Chronic local.* Materials which on continuous or repeated exposures extending over periods of days, months, or years can cause injury to skin or mucous membranes of sufficient severity to threaten life or cause permanent impairment, which disfigurement, or irreversible change.

(d) *Chronic systemic.* Materials which can be absorbed into the body by inhalation, ingestion or through the skin and which can cause death or serious physical impairment following continuous or repeated exposures to small amounts extending over periods of days, months, or years.

*Sax, N.I., Dangerous Properties of Industrial Materials, Van Nostrand Rheinhold Company, New York, 4th Edition, 1975.
**Sax, N.I., Dangerous Properties of Industrial Materials, Van Nostrand Rheinhold Company, New York, 5th Edition, 1979.

3.5 Targets

Ground water use indicates the nature of the use made of ground water drawn from the aquifer of concern within 3 miles of the hazardous substance, including the geographical extent of the measurable concentration in the aquifer. Assign a value using the following guidance:

Ground Water Use	Assigned Value
Unusable (e.g., extremely saline aquifer, extremely low yield, etc.)	0
Commercial, industrial or irrigation and another water source presently available; not used, but usable	1
Drinking water with municipal water from alternate unthreatened sources presently available (i.e., minimal hookup requirements); or commercial, industrial or irrigation with no other water source presently available	2
Drinking water; no municipal water from alternate unthreatened sources presently available	3

Distance to nearest well and population served have been combined in the matrix below to better reflect the important relationship between the distance of a population from hazardous substances and the size of the population served by ground water that might be contaminated by those substances. To determine the overall value for this combined factor, score each individually as discussed below. Match the individual values assigned with the values in the matrix for the total score.

Value for Population Served	Value for Distance to Nearest Well 0	1	2	3	4
0	0	0	0	0	0
1	0	4	6	8	10
2	0	8	12	16	20
3	0	12	18	24	30
4	0	16	24	32	35
5	0	20	30	35	40

<u>Distance to nearest well</u> is measured from the hazardous substance (not the facility boundary) to the nearest well that draws water from the aquifer of concern. If the actual distance to the nearest well is unknown, use the distance between the hazardous substance and the nearest occupied building not served by a public water supply (e.g., a farmhouse). If a discontinuity in the aquifer occurs between the hazardous substance and all wells, give this factor a score of 0, except where it can be shown that the contaminant is likely to migrate beyond the discontinuity. Figure 6 illustrates how the distance should be measured. Assign a value using the following guidance:

Distance	Assigned Value
>3 miles	0
2 to 3 miles	1
1 to 2 miles	2
2001 feet to 1 mile	3
< 2000 feet	4

Population served by ground water is an indicator of the population at risk, which includes residents as well as others who would regularly use the water such as workers in factories or offices and students. Include employees in restaurants, motels, or campgrounds but exclude customers and travelers passing through the area in autos, buses, or trains. If aerial photography is used, and residents are known to use ground water, assume each dwelling unit has 3.8 residents. Where ground water is used for irrigation, convert to population by assuming 1.5 persons per acre of irrigated land. The well or wells of concern must be within three miles of the hazardous substances, including the area of known aquifer contamination, but the "population served" need not be. Likewise, people within three miles who do not use water from the aquifer of concern are not to be counted. Assign a value as follows:

Population	Assigned Value
0	0
1-100	1
101-1,000	2
1,001-3,000	3
3,001-10,000	4
>10,000	5

One-year 24-hour rainfall (obtained from Figure 8) indicates the potential for area storms to cause surface water contamination as a result of runoff, erosion, or flow over dikes. Assign a value as follows:

Amount of Rainfall (inches)	Assigned Value
<1.0	0
1.0-2.0	1
2.1-3.0	2
>3.0	3

Distance to the nearest surface water is the shortest distance from the hazardous substance, (not the facility or property boundary) to the nearest downhill body of surface water (e.g., lake or stream) that is on the course that runoff can be expected to follow and that at least occasionally contains water. Do not include man-made ditches which do not connect with other surface water bodies. In areas having less than 20 inches of normal annual precipitation (see Figure 5), consider intermittent streams. This factor indicates the potential for pollutants flowing overland and into surface water bodies. Assign a value as follows:

Distance	Assigned Value
>2 miles	0
1 to 2 miles	1
1000 feet to 1 mile	2
<1000 feet	3

Physical state is assigned a value using the procedures in Section 3.2.

1 YEAR 24-HOUR RAINFALL (inches)

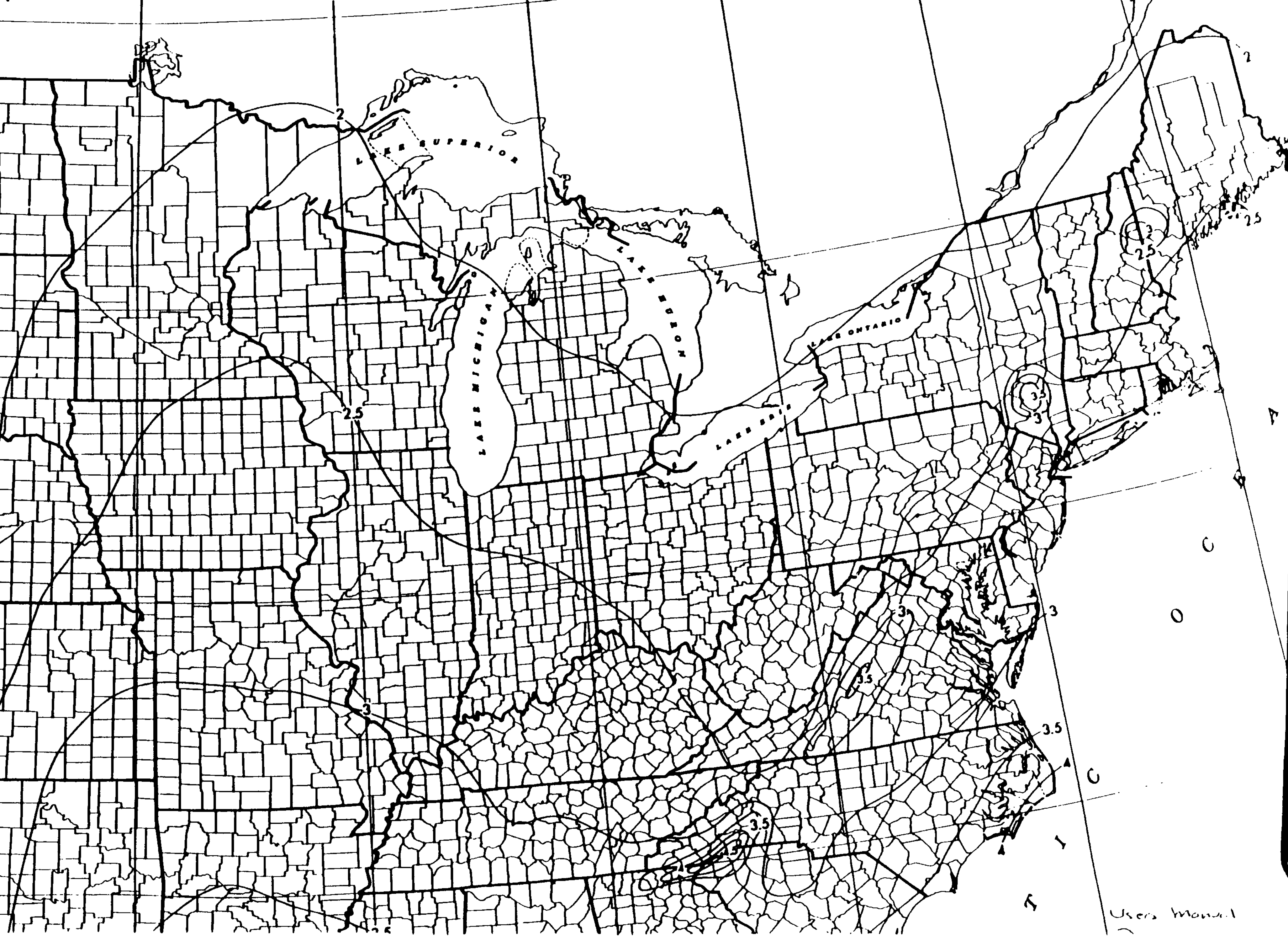


TABLE 9

CONTAINMENT VALUES FOR SURFACE WATER ROUTE

Assign containment a value of 0 if: (1) all the waste at the site is surrounded by diversion structures that are in sound condition and adequate to contain all runoff, spills, or leaks from the waste; or (2) intervening terrain precludes runoff from entering surface water. Otherwise, evaluate the containment for each of the different means of storage or disposal at the site and assign a value as follows:

A. Surface Impoundment

	Assigned Value
Sound diking or diversion structure, adequate freeboard, and no erosion evident	0
Sound diking or diversion structure, but inadequate freeboard	1
Diking not leaking, but potentially unsound	2
Diking unsound, leaking, or in danger of collapse	3

B. Containers

	Assigned Value
Containers sealed, in sound condition, and surrounded by sound diversion or containment system	0
Containers sealed and in sound condition, but not surrounded by sound diversion or containment system	1
Containers leaking and diversion or containment structures potentially unsound	2
Containers leaking, and no diversion or containment structures or diversion structures leaking or in danger of collapse	3

C. Waste Piles

	Assigned Value
Piles are covered and surrounded by sound diversion or containment system	0
Piles covered, wastes unconsolidated, diversion or containment system not adequate	1
Piles not covered, wastes unconsolidated, and diversion or containment system potentially unsound	2
Piles not covered, wastes unconsolidated, and no diversion or containment or diversion system leaking or in danger or collapse	3

D. Landfill

	Assigned Value
Landfill slope precludes runoff, landfill surrounded by sound diversion system, or landfill has adequate cover material	0
Landfill not adequately covered and diversion system sound	1
Landfill not covered and diversion system potentially unsound	2
Landfill not covered and no diversion system present, or diversion system unsound	3

REFERENCE NO. 13

06370
02-8804-09

NUS CORPORATION

TELECON NOTE

CONTROL NO: 02-8804-09	**DATE:** 4-14-89	**TIME:** 2:45pm

DISTRIBUTION:

Site Information

BETWEEN: Sergio Leone	**OF:** Union ~~CAL~~ G.C. Chemical	**PHONE:** (201) 541-4224

AND: G. A. Calabrese (NUS)

DISCUSSION:

The two Black tanks along Nows creek were used for filtering the carbon groundwater under the site and dispensing it into a drainage ditch. No waste source is ~~stored~~ stored at the Union Chemical site.
G.C. 4-14-89

ACTION ITEMS:

NUS 087 REVISED 0581

REFERENCE NO. 14

FINAL REPORT
ADDITIONAL SITE ASSESSMENT
FOR THE
UNOCAL CHEMICALS/CARTERET SITE
CARTERET, NEW JERSEY

PREPARED FOR:

UNION OIL COMPANY OF CALIFORNIA
UNOCAL CHEMICALS DIVISION
SCHAUMBURG, ILLINOIS

DECEMBER 1986
PROJECT NO. 303331

PREPARED BY:

IT CORPORATION
PITTSBURGH, PENNSYLVANIA

Addition Site Assessment

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FINAL REPORT

ADDITIONAL SITE ASSESSMENT
UNOCAL CHEMICALS/CARTERET SITE
CARTERET, NEW JERSEY

1.0 INTRODUCTION

IT Corporation (IT) was retained in July 1985 by the Unocal Chemicals Division of the Union Oil Company of California (Unocal Chemicals) to conduct an initial site assessment at their facility in Carteret, New Jersey (Figure 1). The purpose of this initial site assessment was to define the in situ geologic and hydrogeologic conditions and to estimate the extent of possible ground water contamination at the site. The information collected during this assessment was then to be used to develop possible site remediation plans which would address the further seepage of organic contaminants into Noes Creek. A number of preliminary plans were developed; however, as this task proceeded, it became obvious that additional geologic and hydrogeologic data were needed at several key locations within the site before detailed design could be completed.

Following a discussion between Unocal Chemicals and IT relative to the findings of the Initial Site Assessment Report (ISAR) and Remediation Alternatives Report, it was decided that an additional site assessment program should be undertaken. A set of data collection objectives was established as a basis for the additional site assessment work. These objectives focused on the collection of the data which were needed to allow the design and construction phases of the project to proceed and included:

- The collection of additional hydrogeologic, geologic, and chemical data to better characterize the deeper sand and gravel aquifer (deeper aquifer) which was found beneath the site during the initial site assessment

- The collection of data to determine if site contaminants are migrating through the railroad ballast toward Roosevelt Avenue at the northeastern corner of the site

- The collection of data to characterize the potential for vertical leakage through the barrier between the shallow and deeper aquifers

- The collection and analysis of additional ground water samples to further characterize the relative qualities of the shallow and deeper aquifer waters and to determine if any correlations exist between the site's established analytical program parameters and possible indicator parameters such as total organic carbon (TOC) and total organic halogen (TOX)

- The collection of water samples from Noes Creek to determine the potential impact of the site on the chemical composition of the stream.

The report which follows presents the results of the work which was completed during the additional site assessment program. The findings of this report are intended to supplement the preliminary findings and conclusions of the ISAR.

The remainder of the report consists of descriptions of the field operations which were conducted during the data collection effort (Chapter 2.0), a discussion of the results of the field investigation (Chapter 3.0), and the presentation of the conclusions and findings of the additional site assessment program (Chapter 4.0).

2.0 FIELD INVESTIGATION

The field investigation program was designed to better define the geology and hydrogeology within two portions of the site in particular. The first portion is located along the property line at the northern end of the site, and the second portion is located between existing Monitoring Wells 6 and 11 (Figure 2). The northern property line area was evaluated for two reasons; first, to expand the scope of the hydrogeologic portion of the overall field investigation to include the entire site area and, second, to collect information which might indicate whether contaminant migration is occurring near this property line. The Monitoring Well 6/11 area required further evaluation because it comprises a portion of the general area which will be impacted by proposed remedial action measures. The field operations for the additional site assessment program included the following tasks:

- Soil drilling and sampling
- Monitoring well installation and development
- Ground and surface water sampling

- Measurements of water levels
- Hydraulic conductivity testing
- Geodetic survey of monitoring wells and borings.

The work for this program was generally completed in the order presented above during the time period of June 2 through 7, 1986.

2.1 DRILLING AND SOIL SAMPLING

Six 6-inch-outside-diameter soil borings were drilled to selected depths into the shallower surface fills and natural soils using a truck-mounted drilling rig and hollow-stem augers. Two additional soil borings were drilled into the deeper natural soils (sands and gravels) using this same equipment. However, these deeper borings consisted of 12-inch-outside-diameter openings for the upper segments of the borings and 6-inch-outside-diameter openings for the lower segments. The need for these multiple borehole diameters is explained in Section 2.2. Figure 2 shows the locations of the eight new soil borings as well as the locations of the previously installed monitoring wells.

Soil samples were obtained both continuously and at selected intervals using a two-inch-outside-diameter split-barrel sampler or new Shelby tube decontaminated for each sample. The split-barrel sampler was driven ahead of the augers by a 140-pound hammer dropped 30 inches to provide Standard Penetration Test data (American Society for Testing and Materials [ASTM] Procedure D1586). Soil sample composites were collected from two-foot intervals starting at the ground surface. Each soil sample was placed in a new, clean 500-milliliter amber glass jar and sealed with a polyethylene-lined cap.

Two undisturbed soil samples were obtained for laboratory permeability testing from the barrier layer between the site's shallow and deeper aquifers. These samples were collected from Borings SB-1 and SB-2 using standard three-inch-diameter Shelby tubes pushed hydrostatically into the soils. Once satisfactory penetration was accomplished, a minimum of ten minutes was allowed to pass before sample recovery was attempted. This waiting period allowed for adequate reexpansion of the soils in the tube, ensuring better recovery. Upon recovery, each tube was properly labeled, sealed, and maintained in its upright normal orientation pending shipment.

Logs describing both the visual classification of the soils and the drilling conditions were prepared by the IT geologist supervising the operations (Appendix A). Four generalized geologic sections were prepared from these boring logs to characterize the underlying site stratigraphy (Figure 3). The locations of these sections are indicated in Figure 2.

Measurements of the concentrations of volatile organic vapors were obtained from the headspace regions of the soil sample jars by means of an H-nu photo-ionization meter. These measurements, which are listed in Table 1, provide an indication of the relative presence of volatile organic constituents in the site soils.

At the completion of the field program, all soil samples were transported, with completed chain-of-custody forms, to the IT laboratory in Export, Pennsylvania (IT laboratory) for temporary archiving. The samples arrived at the laboratory on June 10, 1986.

2.2 MONITORING WELL INSTALLATION AND DEVELOPMENT

Monitoring wells were installed in six of the eight soil borings to allow for the collection of ground water samples for chemical analysis and to provide a means for obtaining water level information for assessing the direction and rate of ground water flow. The installed wells consisted of the following components:

- Two-inch-inside-diameter stainless steel pipe with flush threads
- Wire-wound stainless steel well screen with 0.010-inch slots
- Sand filter pack
- Bentonite seal
- Grout seal
- Locking cap
- Protective cover.

Upon completion of an appropriate soil boring, a stainless steel well screen and pipe were assembled and installed in the boring as instructed by the on-site IT geologist. Following placement of the well screen and pipe, a filter pack of silica sand (sand pack) was placed in the annulus between the well screen and the boring perimeter. The sand pack was generally installed such that the top of the pack was approximately one foot above the top of the well screen. A bentonite seal was installed on top of the sand pack to seal off the screened zone. Periodic depth measurements were made during the installation of both the sand pack and bentonite seal to ensure proper placement. A grout seal was then installed up to the ground surface in the remaining annular space of the well to impede the infiltration of surface water into the well. A locking cap was installed on the top of the riser pipe and a lamphole cover was set (in mortar) above the riser pipe but flush with the ground surface.

Two monitoring wells, MW-14 and MW-16, were installed into the deeper aquifer. The construction techniques for these installations were similar to those for the installations of the other wells but with additional placements of grout-filled, 10-inch-diameter polyvinyl chloride (PVC) casings within the upper portions of these borings. Construction of the wells involved augering 12-inch-diameter holes through the fill and six inches into the generally silty-clay and peat barrier layer which separates the shallow and deeper aquifers. Casings comprised of 10-inch-diameter PVC pipe were then installed in these holes and were seated into the generally silty-clay and peat layer. The cased openings were then filled with a bentonite grout mixture. The mixture was allowed to cure for about 12 hours before operations continued. The six-inch-diameter auger was then advanced through the grout mixture and into the underlying natural soils, and the well installations proceeded normally as described above.

The reason for the casing and grouting of the larger-diameter holes prior to drilling the well boring through the barrier layer and into the deeper aquifer was to minimize the possibility of cross-aquifer contamination. Such a precaution was not taken during the initial site assessment installations of Monitoring Wells 2 and 7 due to the unknown existence of the separate deeper aquifer at the time. Therefore, the analytical results for the previously obtained water samples from these wells are suspect.

The new well completion diagrams are presented in Appendix B. Monitoring well and soil boring elevations for the entire site are presented in Table 2. Comparison of the "top of well screen" elevations with the ground water elevations measured in corresponding wells (Table 3) indicates that at times a number of the shallow aquifer well screens (i.e., Monitoring Wells 6, 9, 10, 11, 12, and 13) have been totally submerged by the ground water. The implication of these occurrences will be discussed in Section 3.4.

The new wells, except for Monitoring Well 15 which was dry, were developed by pumping to remove fines from the well sensing zone to enhance communication between the water-bearing zone and the well. While pumping proceeded, the effluent was visually monitored for suspended solids content. When it was determined that the suspended solids content had diminished sufficiently, and at least three well volumes had been pumped from the well, development was assumed to be completed. All downhole equipment used to develop the wells was decontaminated between wells using hexane and methanol washes followed by distilled water rinses.

2.3 GROUND AND SURFACE WATER SAMPLING

Ground water samples were collected for chemical analysis on June 6 and 7, 1986 from 17 of the 18 on-site monitoring wells. Monitoring Well 15 was dry at the time the samples were collected. Prior to sampling, each well was purged of a minimum of three well volumes of water by bailing. Bailing and sampling were accomplished using a decontaminated point-source teflon bailer. Decontamination consisted of thoroughly washing the bailer using hexane then methanol followed by repeated rinsing with distilled water. The samples were generally obtained from the upper to middle portions of the water columns in the respective wells. Apparent "free product" was again visually observed in Monitoring Wells 5, 6, and 8, and a sample of the most obvious free product layer in Monitoring Well 6 was collected for analysis.

Two surface water samples were also collected on June 6, 1986 from Noes Creek for chemical analysis. Both samples were collected simultaneously during ebb tide by immersing the appropriate sample bottles in the creek water at the locations indicated in Figure 2. The water was approximately one-foot deep at the points of sampling. The locations of the samples, S-1 and S-2, were chosen to represent conditions just upstream and just downstream, respectively, of the site.

Standard field parameters, i.e., sample temperature, pH, and specific conductance, were measured and recorded in the field for all water samples (Appendix C). Each sample was placed in a new, clean container, was appropriately preserved, and was then cooled to and maintained at wet ice temperature (four degrees Celsius) during transport to the IT laboratory. All samples were transported by means of ground transportation and were accompanied by completed chain-of-custody forms. The samples arrived at the laboratory on June 10, 1986 and were subsequently analyzed for the required constituents.

2.4 GROUND WATER LEVEL MEASUREMENTS

Measurements of the ground water levels in all monitoring wells were taken during both high and low tides on June 6 and 7, 1986, respectively. These measurements were manually obtained using a weighted sounding device attached to a measuring tape. The measurements were recorded on log sheets to the nearest 0.01 foot. The results of this water level measurement program are indicated in Table 3 along with results of previous measurement programs. Generalized ground water contour maps for the shallow aquifer were developed from these measurements and are presented in Figures 4 (high tide) and 5 (low tide).

2.5 HYDRAULIC CONDUCTIVITY TESTING

In situ permeability tests were conducted in Monitoring Wells 1 and 8 (Figure 2) following the above-described collection of ground water samples and measurement of water levels. The tests were performed to evaluate present well sensitivity (degree of communication between the well and water-bearing zone) and to estimate, or in the case of Monitoring Well 1 reestimate, the hydraulic conductivities of the water-bearing zones at the chosen locations. The tests were conducted by filling the well pipes with water to levels above the existing ground water levels in these wells and measuring the subsequent falls of these induced water levels as a function of time (falling head test).

The induced water level in Monitoring Well 8 dropped so rapidly to its original elevation that an acceptable measurement of this fall over time could not be obtained using available techniques. This occurrence cannot categorically be explained at this time except for the possibility that Monitoring Well 8 may intersect a thin, isolated lens of high-permeability fill material which is located above the normal water level in the well. Thus, no hydraulic conductivity value could be calculated for this well.

The hydraulic conductivity value of Monitoring Well 1 resulting from the falling head test was computed to be 4.7×10^{-4} centimeter per second (cm/s). This result is consistent with the previous rising head test result of 2.1×10^{-4} cm/s which was obtained for Monitoring Well 1 during the initial site assessment program. This outcome tends to also reinforce the credibility of the other hydraulic conductivity results which were obtained during the initial site assessment and ranged from 1.3×10^{-5} to 3.5×10^{-3} cm/s.

2.6 GEODETIC SURVEY OF MONITORING WELLS AND BORINGS

A geodetic survey was conducted at the site by Ensurplan (formerly Goodman Allgair and Scott), a local, registered surveying company, to provide both vertical and horizontal control for all monitoring wells and soil borings. Elevations were determined to the nearest 0.01 foot for the near-ground surface, the top of protective cover, and the top of riser pipe for all monitoring wells; and for only the near-ground surface for Borings SB-1 and SB-2. Wells and borings were horizontally located by measuring radial distances to permanent site structures. Well locations and pertinent elevations are provided in Figure 2 and Table 2, respectively.

3.0 RESULTS OF INVESTIGATION

The previous chapter provided a description of the field operations conducted during this additional site assessment. The following sections present discussions of both the criteria on which the project objectives (Chapter 1.0) and the plan of work were based, and the results of this work.

3.1 ADDITIONAL CHARACTERIZATION OF DEEPER AQUIFER

A sand and gravel aquifer (deeper aquifer) was found to exist at depths which varied from approximately 12 to 27 feet beneath the surface of the site during the initial site assessment program. The following work was planned as part of the additional site assessment program to better define the lateral extent of this deeper aquifer and its relationship to the shallow aquifer:

- Soil boring and soil sample collection
- Monitoring well installation
- Ground water sample collection and analysis
- Ground water level measurement.

As described in Section 2.2, two additional deep borings, MW-14 and MW-16, were drilled on site to supplement the information obtained from the drilling of Monitoring Wells 2 and 7 during the initial site assessment program (refer to Figure 2 for locations of wells). The locations of the new borings were chosen such that if the sand and gravel formation was again encountered in both of these borings, it could then be assumed that this soil layer extended beneath the entire site. Both borings did encounter this layer (Appendix A); therefore, it has been assumed, for the purposes of this report (i.e., cross sections, etc.), that the sand and gravel formation does extend beneath the entire site. note

Monitoring wells were installed in each of the two borings for the purpose of collecting ground water samples and determining ground water levels. The information obtained from both the ground water analyses and the water level measurements was intended to be used to better define the hydrogeologic relationship between the overlying shallow aquifer and this deeper aquifer.

The results of the ground water analyses are discussed in detail in Section 3.4. However, these results generally imply that the potential for migration of contaminants from the shallow aquifer, through the existing barrier layer, and into the deeper aquifer may not be as great or extensive as the initial site assessment analytical results may have suggested. The deeper aquifer Monitoring Well 16 was found to be relatively "clean," while the closest of the nearby shallow aquifer wells for which the complete list of volatile constituents was measured, Monitoring Well 17 (Figure 2), appeared to be potentially contaminated (Table 4). The deeper aquifer Monitoring Well 14 was also found to be relatively "clean" although this well is likely upgradient from the on-site contaminant sources. Thus, a definitive statement about the relationship between the shallow and deeper aquifers, relative to the integrity of the barrier layer in minimizing contaminant migration, cannot be made at this time in light of the existing water quality data. Additional data are needed for evaluation prior to the formulation of any conclusions on this matter.

The evaluation of the ground water elevation data contained in Table 3 regarding the quantification of the vertical gradient which should exist between the shallow and deeper aquifers indicates that this gradient likely varies with time in both magnitude and direction. This outcome is predictable in a tidally influenced environment such as exists on site. Thus, the existing ground water elevation data are not sufficient for developing meaningful conclusions or observations relative to the impact of natural piezometric head differential on the potential for contaminant migration through the barrier layer between the aquifers. Continuous ground water level measurements must be acquired before a realistic piezometric relationship between the shallow and deeper aquifers can be established. It can, however, be stated that an "upward" vertical gradient appears to have, at least intermittently, existed and may still intermittently exist. These occurrences will tend to minimize the potential for downward migration of contaminants from the shallow aquifer.

3.2 CONTAMINANT MIGRATION THROUGH THE RAILROAD BALLAST

The area in question is located in the northeastern section of the site near Roosevelt Avenue where the railroad track runs between the plant office and warehouse. The additional work planned for this area included the installation of a ground water monitoring well, MW-15 (Figure 2), from which soil and water samples could be collected. It was reasoned that the selected well location should be in the pathway of any ground water which had the potential to flow away from the site through the typically highly permeable track ballast. Ground water samples were to be collected from this well for analysis to determine if contaminants might also be migrating with such ground water. The well was installed in the upper fill with the bottom of the screened interval located in the top of the generally silty-clay and peat barrier layer beneath the fill. However, an insufficient amount of ground water flowed into the well during the course of the field work, and the plan to collect and analyze ground water samples from this well had to be abandoned.

The fact that the well was essentially dry following installation does allow an observation to be made concerning this area. That is, it does not appear that the shallow aquifer extends into this local area under normal weather and low tide conditions. Supporting this observation are the soil boring logs (Appendix A) and geologic cross sections (Figure 3) which indicate that the top of the generally silty-clay and peat barrier layer, above which the shallow aquifer is perched, slopes away from this area toward the southern and central portions of the site. Thus, the probable intermittent occurrence of ground water in this area minimizes the potential for localized off-site contaminant migration through the railroad ballast. ← note

3.3 LEAKAGE POTENTIAL OF BARRIER LAYER

Concern over the possibility of leakage of the shallow aquifer contaminants into the deeper aquifer dictated the need for evaluating the leakage potential of the generally silty-clay and peat barrier layer which exists between the aquifers. ← note The evaluation was to be based on the results of the ground water level measurement program and the results of laboratory permeability testing of the two samples which were collected from the barrier layer during the field operations (Section 2.1). Additionally, insight was hoped to be gained from the results of the ground water sample analyses.

As discussed in the previous section and as will be discussed in Section 3.4, existing ground water quality data are inconclusive with respect to supporting or denying the occurrence of past substantial leakage and associated contaminant migration from the shallow aquifer into the deeper aquifer. Thus, a qualitative means of characterizing the leakage potential of the barrier layer is not presently available. As has also been discussed, the existing ground water elevation data are too sparse and discontinuous to be used to quantify the relative magnitude and dominant direction of leakage. Thus, one of the primary means of characterizing the leakage potential is not presently available. However, the results of the laboratory permeability testing indicate that the barrier layer, at least in the general areas sampled, is not very ← is not permeable is this [illegible] permeable. This outcome will tend to minimize the potential for downward leakage in these areas and in other areas where the barrier layer has similar properties.

The laboratory permeability tests were conducted in the IT laboratory. The two undisturbed samples on which the tests were conducted were collected from the generally silty-clay and peat layer which was encountered in Borings SB-1 and SB-2 (Figure 2), as previously described. The results of the permeability tests are provided in Appendix C. These results indicate that the portion of the barrier layer represented by the SB-1 sample has a permeability on the order of 3.1×10^{-8} cm/s, and the portion of the barrier layer represented by the SB-2 sample has a permeability on the order of 2.4×10^{-8} cm/s. These results compare favorably with the permeabilities typical of soil-bentonite design mixes used in the construction of slurry walls which are themselves often used to contain contaminated subsoils and/or ground water. Thus, the represented barrier layer materials can be described as low-permeability materials which will tend to minimize potential leakage, but the magnitude of this leakage cannot be quantified at this time. ← note

3.4 GROUND WATER QUALITY EVALUATION

The results of the analyses of the ground water samples which were collected from the new monitoring wells are presented in Tables 4 and 5. Monitoring Well 15 is not represented in these tables since samples could not be obtained as explained previously. The results of the analyses of the ground water samples which were collected from the remaining monitoring wells during the additional site assessment are presented in Table 5.

Shallow Aquifer

The Table 4 results regarding the shallow aquifer indicate that the Monitoring Well 13 area appears to be relatively "clean," whereas the Monitoring Well 17 and 18 areas may be somewhat contaminated. All measured volatile organic constituents, if they existed at all, were found to be below the analytical method detection limits for Monitoring Well 13. The Monitoring Well 17 analyses found a number of elevated volatile organic concentration levels, with total xylenes and toluene having the highest levels among the more hazardous constituents (i.e., benzene, chlorobenzene, ethylbenzene, tetrachloroethylene, toluene, [1,1,1]-trichloroethane, vinyl chloride, and xylene, as per the

"Qualitative Risk Assessment" section of the ISAR). The Monitoring Well 18 analyses also found a number of elevated volatile organic concentration levels, with chlorobenzene, benzene, and total xylenes having the highest levels among the more hazardous constituents.

These shallow aquifer analytical results coupled with the initial site assessment analytical results for the shallow aquifer (reproduced as Table 6 herein) have allowed the development of a graphical depiction of the suspected General Contaminant Source Area (GCSA) within the shallow aquifer (Figure 6). The limits of the GCSA boundary were approximated from consideration of the general facility layout and operation, the site stratigraphy, and the analytical data. The major storage tank operations are associated with the interior of the site, and a review of the site stratigraphy indicates that the top of the barrier layer tends to slope away from the northern, eastern, and western boundaries and toward the central and southern portions of the site. Review of the analytical data of Tables 4 and 6 for the shallow aquifer wells indicates that the measured concentrations of the more hazardous constituents (defined above) for the wells within the GCSA limits are on the order of a magnitude or more greater than the corresponding measured concentrations of these constituents for the wells outside of the GCSA. Thus, the GCSA provides a visual interpretation of the existing shallow aquifer analytical data relative to the greatest concentrations of contaminants and represents the most likely area in need of remediation.

Deeper Aquifer

The Table 4 results regarding the deeper aquifer wells indicate that both Monitoring Wells 14 and 16 appear to be relatively "clean." All measured volatile organic constituents, if they existed at all, were found to be below the analytical method detection limits for Monitoring Well 16. The same was true for Monitoring Well 14, except for the measured presence of chloroform and tetrachloroethylene which were found in concentrations slightly above their detection limits and for the measured presence of trichloroethylene which was found at a level within an order of magnitude of its detection limit. Only tetrachloroethylene belongs to the "more hazardous constituent" group which was previously defined.

In comparing the deeper aquifer analytical results for Monitoring Wells 14 and 16 (Table 4) with those previously obtained during the initial site assessment for Monitoring Wells 2 and 7 (Table 6), it must be noted that Monitoring Wells 2 and 7 were installed without the precautionary measures employed during the installation of Monitoring Wells 14 and 16 (Section 2.2). Thus, it is possible that the analytical results reported for Monitoring Wells 2 and 7 may reflect conditions affected by the drilling operations even though the standard installation, development, and purging procedures were closely adhered to at the time that these wells were installed and sampled. The existence of a significant site-related contaminant plume in the deeper aquifer cannot, therefore, be verified at this time, especially in light of the analytical results for Monitoring Wells 14 and 16. However, the existing data do indicate that, if a plume actually exists, it is not very extensive relative to the northern, western, and eastern site boundaries.

The acquisition of additional analytical data is needed for review before a definitive conclusion can be drawn regarding the contamination of the deeper aquifer. The analysis of new water samples from Monitoring Wells 2 and 7 alone could provide a valuable indication as to whether the previously mea- NOTE sured contaminant levels at these wells were actually representative of the formation water. Because more than a year has passed since these wells were initially sampled (September 1985), the aquifer has had a chance to "cleanse" itself of the typically soluble and mobile volatile organic constituents which might have been introduced during well installation. Thus, if such new samples were to contain significantly reduced levels of the constituents which were previously present, then the original data were likely not representative of the actual deeper aquifer water quality.

Indicator Parameters

The results of the most recent analyses for TOC and TOX are presented in Table 5. The results of the previous analyses for these parameters during the initial site assessment are presented in Table 6. Review of both sets of results indicates that neither of the parameters can be depended upon to be a reliable, consistent indicator of the occurrence and/or relative magnitude of elevated levels of the more hazardous constituents (as defined previously) associated with the site. For example, Table 6 indicates that Samples MW-1T, MW-7T, MW-10T, and MW-10B all have TOC values in the range of 12 to 14 parts per million (ppm); however, Monitoring Well 1 is considered to be relatively "clean" while Monitoring Wells 7 and 10 had significantly elevated levels of chlorobenzene and/or total xylenes. Additionally, the highest TOC concentration in Table 6 corresponds to one of the "cleaner" wells, Monitoring Well 3, while Tables 4 and 5 illustrate that the apparently most contaminated well of those represented in these tables, Monitoring Well 6, did not have the highest TOC concentration. In regard to a similar inconsistency in the TOX measurements, Tables 4 and 5 show that Samples MW-14 and MW-18 had the same TOX concentrations of 1.0 ppm, while Samples MW-16 and MW-17 had the same TOX concentrations of 0.15 ppm; yet Monitoring Wells 14 and 16 appear to be relatively "clean" and Monitoring Wells 17 and 18 may be contaminated. Therefore, it cannot be recommended that the TOC and TOX parameters be used to substitute for the actual measurements of the more hazardous constituent concentrations.

<u>Future Sampling Protocol</u>

It has become apparent that several of the shallow aquifer well screens have been totally submerged at times in the past by the ground water (Section 2.2). These occurrences are not necessarily detrimental to the use of any of the monitoring wells or to the existing analytical results of samples obtained from the wells. However, there is the possibility that a sample collected from or near the top of the water column in a well which has had its well screen submerged for any length of time may not actually be representative of the top of the water table outside of the well at the time of sampling. This may especially be true in an environment where free product may be present atop the ground water table. Thus, to ensure that representative samples are being obtained during any future ground water sampling program, water level measurements should be taken prior to sampling and "top" samples should be collected only if and when the water level in a particular well is below its top-of-well-screen elevation. The relative elevations of the ground water table and the top of a well screen should not impact the collection of a "bottom" sample from a given well.

3.5 SURFACE WATER QUALITY EVALUATION

Two water samples were collected from Noes Creek, one west (SW-1) and one east (SW-2) of the site (Figure 2). The locations were chosen such that during ebb tide it was expected that the quality of the water flowing to location (SW-1) would not be influenced by the site and, conversely, the quality of the water flowing to location (SW-2) would be influenced by the site. The results of the analyses indicate that for all parameters measured in excess of their detection limits, except sulfate, concentrations were higher upstream (SW-1) than downstream (SW-2). This occurrence may be attributable to a presently unknown off-site, upstream source of contamination or possibly to the entrainment of site-related constituents as the tide moves up Noes Creek past the site. In any event, the limited surface water sampling program does tend to demonstrate that the concentrations of the more hazardous volatile organic constituents measured in Noes Creek are significantly lower than the concentrations of these constituents measured in the on-site shallow aquifer. Apparently, volatile organic contaminant attenuation is occurring which will tend to minimize the possible site-related impairment of Noes Creek. This outcome is most likely due largely to the turbulence and associated mixing which probably occurs as the tide moves past the site. However, a definitive conclusion regarding the degree to which Noes Creek is contaminated with site-related constituents cannot be formalized at this time, except to state that the limited data tend to support the possibility of minimal volatile organic contamination.

4.0 CONCLUSIONS AND FINDINGS

The conclusions and findings of this additional site assessment program are summarized below with respect to the data collection objectives which were outlined in Chapter 1.0:

- Characterization of the deeper sand and gravel aquifer

  - The sand and gravel formation appears to be present beneath the entire lateral extent of the site.

  - The top of the sand and gravel formation was found at depths of 12 to 27 feet below the surface of the site.

  - A generally silty-clay and peat barrier layer appears to be present between the shallow and deeper aquifers. The integrity of this barrier layer relative to the prevention or minimization of downward contaminant migration cannot be fully established at this time. Additional data are needed to be gathered and reviewed to further assess the barrier layer as discussed in Section 3.1.

- o Determination of the potential for migration of contaminants through the railroad ballast

  - The probable intermittent occurrence of ground water in the subject area minimizes the potential for contaminant migration through the railroad ballast. However, the continuous tidal influence on Monitoring Well 15 should be assessed to further justify the above observation.

- o Characterization of the potential for vertical leakage through the barrier layer

  - Laboratory permeability testing on soil samples obtained from the barrier layer yielded results which indicated that the barrier materials may be low-permeability materials which minimize the potential for downward leakage. However, additional data may need to be acquired to verify the areal extent of the low-permeability zone.

= [illegible] section

  - Adequate piezometric and/or water quality data are not presently available to quantify or further qualify the vertical leakage potential. However, the acquisition of the additional data discussed in Section 3.1 should address this matter.

- o Evaluation of ground water quality

  - The GCSA (Figure 6) was developed as a visual interpretation of the existing shallow aquifer analytical data relative to the greatest concentrations of contaminants and to represent the most likely area in which the remediation efforts should be focused.

  - The existence of a site-related contaminant plume in the deeper aquifer cannot be verified at present. Additional ground water quality data are needed for evaluation before a definitive conclusion can be drawn concerning this matter.

  - TOC and/or TOX are not reliable, consistent indicators of the presence of the more hazardous constituents associated with the site.

  - In the future, water level measurements should be taken prior to the collection of a ground water sample from the top of the water column in a well to determine whether the particular well screen is submerged.

- Evaluation of surface water quality

  - The limited data tend to support the possibility of minimal volatile organic contamination of Noes Creek. However, additional data should be acquired before a definitive conclusion is drawn concerning the magnitude of the site-related contamination of Noes Creek.

Sufficient data appear to now exist with which to carry forward the design of a shallow aquifer ground water control scheme to contain, collect, and treat the ground water within the GCSA. The design of the potential ground water collection well system(s) will be dependent on sensitivity analyses conducted on representative values of hydraulic conductivity and horizontal hydraulic gradient for the site. The system(s) will then be adjusted, via pumping rates and well spacings, to account for the "worst" practical conditions. The consideration of the continuous ground water level information discussed in Section 3.1 will, however, allow for the selection of the most representative horizontal hydraulic gradient values.

TABLES

TABLE 2

MONITORING WELL AND SOIL BORING ELEVATIONS(a)

MONITORING WELL OR SOIL BORING	TOP OF COVER OR GROUND	TOP OF INSIDE PIPE(b)	TOP OF WELL SCREEN	BOTTOM OF WELL OR BORING
MW-1	8.98	8.27	4.98	-1.02
MW-2	8.47	7.60	-3.53	-21.53
MW-3	9.31	8.63	7.11	1.31
MW-4	9.30	8.50	7.30	1.30
MW-5	9.16	8.58	7.16	1.16
MW-6	8.84	8.23	4.54	-7.16
MW-7	8.83	7.89	-17.17	-23.17
MW-8	9.43	8.55	7.43	-4.57
MW-9	10.40	9.57	7.40	-4.60
MW-10	10.83	10.01	8.83	2.83
MW-11	11.25	10.43	9.25	3.25
MW-12	12.48	11.79	10.48	4.48
MW-13	12.34	11.74	8.34	2.34
MW-14	13.37	12.53	-5.63	-16.63
MW-15	9.56	9.14	8.06(c)	3.36
MW-16	9.80	9.32	-8.40	-19.40
MW-17	9.63	9.23	5.63	-5.37
MW-18	(d)	(d)	(d)	(d)
SB-1	9.1	-	-	-8.90
SB-2	9.6	-	-	-4.40

(a)Elevations in feet (mean sea level).

(b)Top of the bottom section of the locking cap.

(c)Elevation of the top of sand pack.

(d)Elevations were not measured as the well cover area was flooded at the time of the survey.

NOTE: Monitoring Wells MW-13 through MW-18 were installed during the additional site assessment investigation. Monitoring Wells MW-1 through MW-12 were installed during the initial site assessment investigation.

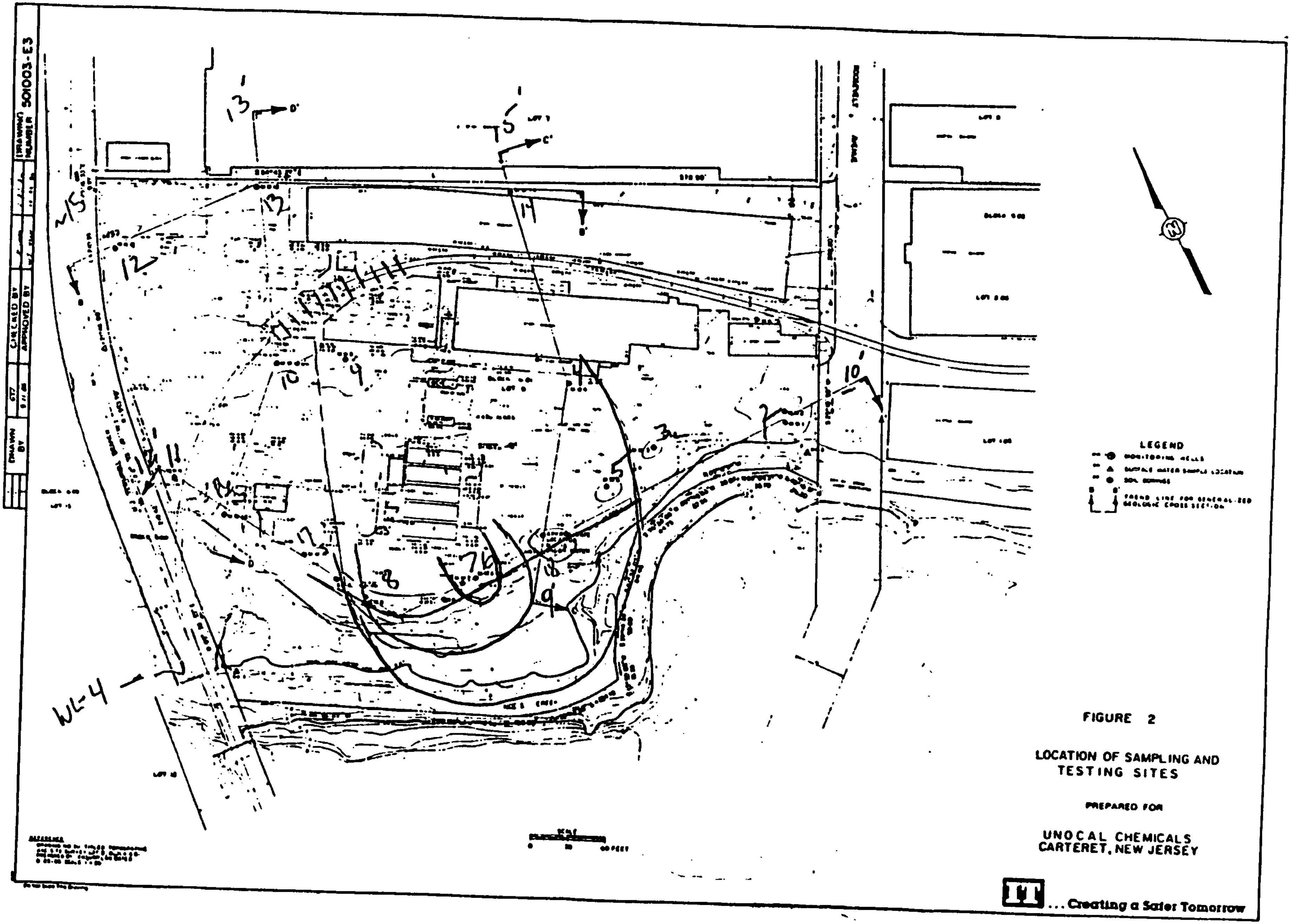


FIGURE 2

LOCATION OF SAMPLING AND TESTING SITES

PREPARED FOR

UNOCAL CHEMICALS
CARTERET, NEW JERSEY

IT ... Creating a Safer Tomorrow

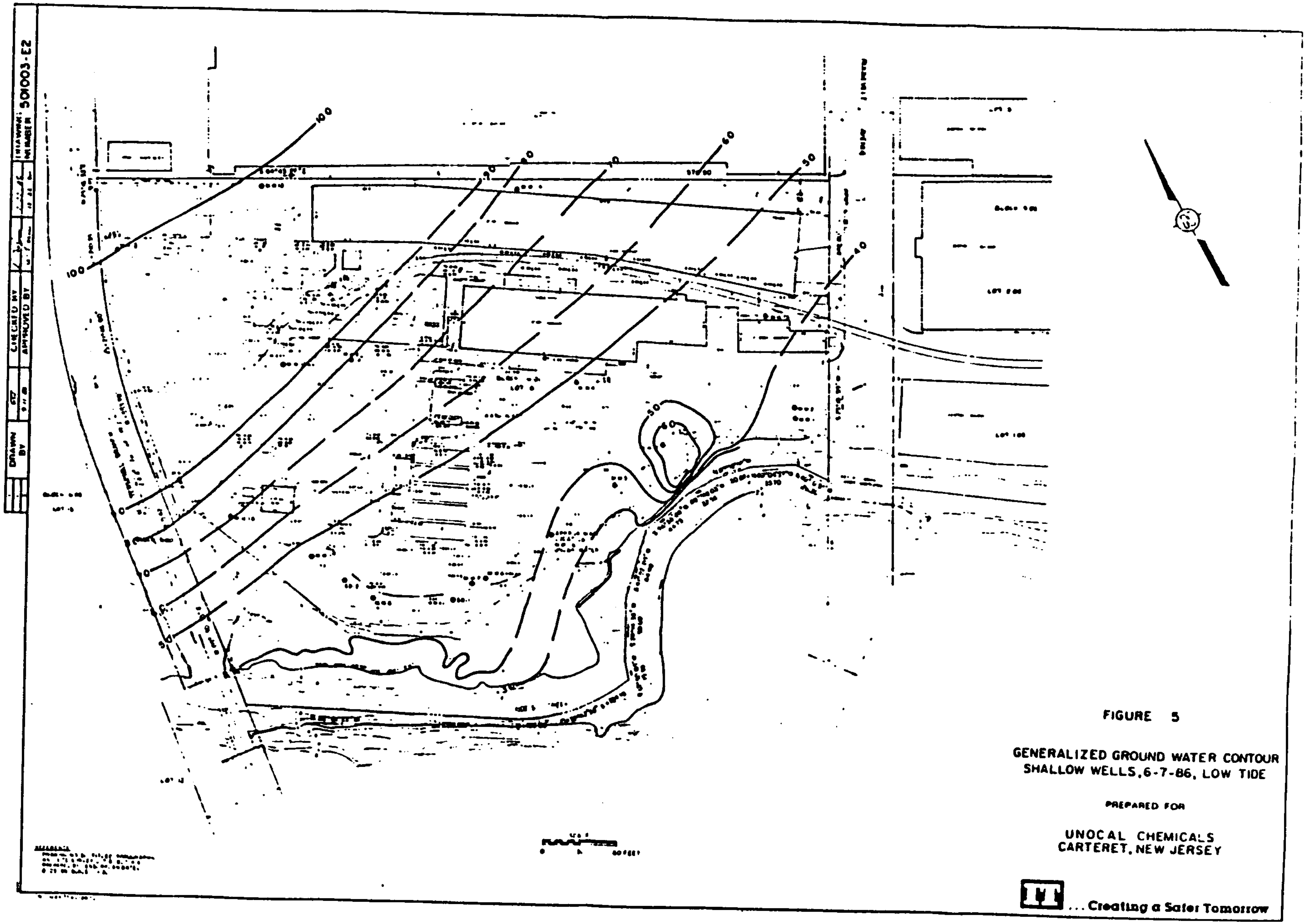


FIGURE 5

GENERALIZED GROUND WATER CONTOUR
SHALLOW WELLS, 6-7-86, LOW TIDE

PREPARED FOR

UNOCAL CHEMICALS
CARTERET, NEW JERSEY

... Creating a Safer Tomorrow

APPENDIX A

SOIL BORING LOGS

GENERAL NOTES AND LEGEND

Symbols to be used for designation of subsurface materials on all boring logs and subsurface sections

ASPHALT

FILL

CONCRETE

VOID (INDICATES SIZE OF VOID)

WATER

APPROXIMATE EXISTING GROUND

APPROXIMATE TOP OF ROCK

GRAVEL

SAND

SILT

CLAY

ORGANIC MATTER

ROOTS

LIMESTONE

SILTSTONE

SANDSTONE

MASSIVE MUDSTONE OR CLAYSTONE

SHALE

COAL

DOLOMITE

CONGLOMERATE

ROCK FRAGMENTS

PEAT

STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2 INCH O. D. SPLIT BARREL SAMPLER 12 INCHES USING A 140 POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER WAS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6 INCH INTERVAL. THE RESISTANCE TO PENETRATION IS INDICATED ON THE DRAWING AS BLOWS PER FOOT.

THE BORING LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THESE BORING LOCATIONS ALSO THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE BORING LOCATIONS

2" O D SPLIT BARREL SAMPLE

75/0 5' PENETRATION REFUSAL, RESISTANCE AND FRACTIONAL INCREMENT DRIVEN IN FEET

1-8-81 GROUND WATER LEVEL AND DATE

U S C S UNIFIED SOIL CLASSIFICATION SYSTEM (CAPITAL LETTERS INDICATE LAB TEST CLASSIFICATION LOWER CASE LETTERS INDICATE VISUAL FIELD CLASSIFICATION)

(60) RQD (ROCK QUALITY DESIGNATION PERCENT) (LENGTH OF NUMBER OF PIECES GREATER THAN 4 INCHES DIVIDED BY THE LENGTH OF THE CORE RUN)

90 INDICATES PERCENT OF CORE RECOVERED (LENGTH OF CORE RECOVERED DIVIDED BY LENGTH OF CORE RUN)

TRACE — INDICATES PRESENCE OF 5 TO 12% OF SUBJECT MATERIAL BY WEIGHT
SOME — INDICATES PRESENCE OF 12 TO 30% OF SUBJECT MATERIAL BY WEIGHT
AND — INDICATES APPROXIMATELY EQUAL PORTIONS OF SUBJECT MATERIAL BY WEIGHT

CONSISTENCY OF COHESIVE SOILS

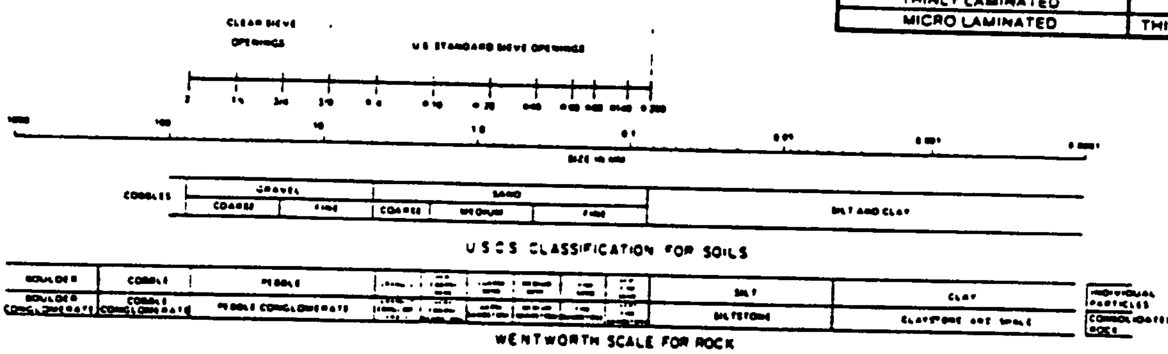
CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH TONS PER SQUARE FOOT
VERY SOFT	LESS THAN 0 25
SOFT	0 25 TO 0 50
MEDIUM STIFF	0 50 TO 1 0
STIFF	1 0 TO 2 0
VERY STIFF	2 0 TO 4 0
HARD	MORE THAN 4 0

DENSITY OF GRANULAR SOILS

DESIGNATION	BLOWS PER FOOT
VERY LOOSE	0 4
LOOSE	5 10
MEDIUM DENSE	11 30
DENSE	31 50
VERY DENSE	OVER 50

TERMS USED TO DESCRIBE BEDDING THICKNESS

VERY THICK BEDDED OR MASSIVE	THICKER THAN 3 3 ft
THICK BEDDED	1-3 3 ft
MEDIUM BEDDED	4 12 in
THIN BEDDED	1-4 in
VERY THIN BEDDED	2/5-1 in
LAMINATED	1/8-2/5 in
THINLY LAMINATED	1/32-1/8 in
MICRO LAMINATED	THINNER THAN 1/32 in



TERMS USED TO DESCRIBE THE RELATIVE DEGREES OF ROCK CORE HARDNESS

DESCRIPTIVE TERMS	DEFINING CHARACTERISTICS
VERY SOFT	CRUSHES UNDER PRESSURE OF FINGERS AND/OR THUMB
SOFT	CRUSHES UNDER PRESSURE OF PRESSED HAMMER
MEDIUM HARD	BREAKS EASILY UNDER SINGLE HAMMER BLOW BUT WITH CRUMBLY EDGES
HARD	BREAKS UNDER ONE OR TWO STRONG HAMMER BLOWS BUT WITH RESISTANT SHARP EDGES
VERY HARD	BREAKS UNDER SEVERAL STRONG HAMMER BLOWS BUT WITH VERY RESISTANT SHARP EDGES AND MAY SPALL LEAVING CONCHOIDAL FRACTURES

THE SPACING OF THE DISCONTINUITIES IN THE ROCK MAY BE DESCRIBED BY ONE OF THE FOLLOWING TERMS

DESCRIPTIVE TERMS	SPACING
VERY BROKEN	LESS THAN 1 IN
BROKEN	1 IN TO 3 IN
SLIGHTLY BROKEN	3 IN TO 6 IN
UNBROKEN	6 IN AND GREATER

DATE BEGAN: 6-5-86

DATE FINISHED: 6-5-86

GROUND SURFACE EL: 9.1'

BORING NO. SB-1

N ______ E ______

FIELD ENGINEER: G. H. & D. H.

CHECKED BY: D. HOLZMAN

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	REMARKS
		S 1		FILL: (MEDIUM DENSE, BROWN FINE SAND, SOME CLAY, BRICK FRAGMENTS AND FINE GRAVEL - MOIST) 2.0'	sp		
6-5-86	2.5	S 2		FILL: (MEDIUM STIFF, BROWN FINE SANDY CLAY, SOME BRICK FRAGMENTS AND FINE GRAVEL - MOIST)	cl		
	5.0	S 3		FILL: (SOFT, BROWN TO BLACK FINE SANDY CLAY, SOME FINE GRAVEL - MOIST) 6.0'	cl		BLACK TAR LIKE MATERIAL PRESENT IN BOTTOM OF S-3 AND TOP OF S-4.
	7.5	S 4		FILL: (LOOSE, BLACK FINE TO COARSE SAND, SOME CLAY, FINE GRAVEL AND BRICK FRAGMENTS - MOIST)	sw		
0.0	10.0	S 5		NO RECOVERY	–		
		S 6		FILL: (VERY LOOSE, DARK BROWN TO BLACK FINE TO COARSE SAND, SOME CLAY, FINE GRAVEL AND BRICK FRAGMENTS - MOIST) 12.0'	sw		
	12.5	S 7		LOOSE, DARK BROWN TO BLACK PEAT, MOIST 14.0'	pt	WOH	
	15.0						
-8.9	17.5 18.0	ST-1 ~29		LOOSE, DARK BROWN TO BLACK PEAT	pt		
				BOTTOM OF BORING 18.0'			

PROJECT NO. 501003

BORING NO. SB-1

SHEET 1 OF 1

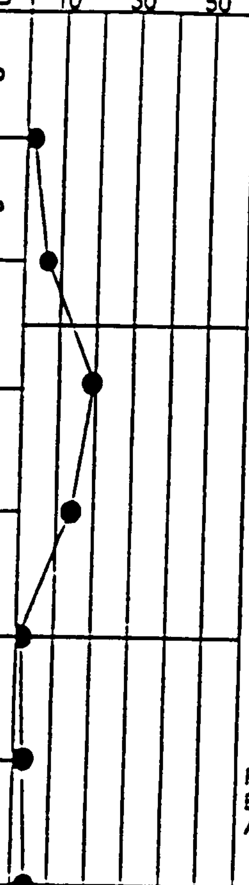
DATE BEGAN: 6-5-86
DATE FINISHED: 6-5-86
GROUND SURFACE EL.: 9.6'

BORING NO. SB-2

N ______ E ______

FIELD ENGINEER: G. H. & D. H.
CHECKED BY: D. HOLZMAN

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	REMARKS
		S 1		FILL: (VERY LOOSE, BROWN FINE SAND, SOME CLAY AND AND SLAG FRAGMENTS - MOIST)	sp		
6-5-86	2.5	S 2		FILL: (LOOSE, BROWN FINE SAND, SOME CLAY, SILT AND BRICK FRAGMENTS - MOIST) 4.0'	sp		
	5.0	S 3		FILL: (MEDIUM STIFF, BROWN TO BLACK FINE SANDY CLAY, SOME TAR LIKE MATERIAL AND METAL FRAGMENTS - MOIST	cl		
	7.5	S 4		FILL: (MEDIUM STIFF, BROWN FINE SANDY CLAY, SOME WOOD FRAGMENTS, TRACE PEAT - MOIST) 8.0'	cl		
0.0	10.0	S 5		FILL: (VERY LOOSE, BLACK FINE TO MEDIUM SAND, SOME SILT, FINE GRAVEL AND WOOD FRAGMENTS - MOIST)	sp		
		S 6		FILL: (VERY LOOSE, BLACK FINE TO MEDIUM SAND, SOME SILT AND WOOD FRAGMENTS - MOIST)	sp		
-4.4	12.5 / 14.0	S 7		FILL: (VERY LOOSE, BLACK FINE TO COARSE SAND, SOME WOOD FRAGMENTS, FINE GRAVEL, PEAT - MOIST)	sp		PEAT ENCOUNTERED AT 14.0'.
				BOTTOM OF BORING 14.0'			



PROJECT NO. 501003

BORING NO. SB-2
SHEET 1 OF 1

DATE BEGAN: 6-3-86
DATE FINISHED: 6-3-86
GROUND SURFACE EL: 12.3'

BORING NO. MW-13

N ______ E ______

FIELD ENGINEER: G. W. & D. H.
CHECKED BY: D. HOLZMAN

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	REMARKS
6-3-86 10.0	2.5	S 1		FILL: (MEDIUM DENSE, BROWN FINE TO MEDIUM SAND, TRACE SILT, BRICK FRAGMENTS AND GRAVEL - MOIST) 2.0'	sw		
	5.0	S 2		MEDIUM DENSE, BROWN FINE TO MEDIUM SAND, TRACE CLAY - MOIST 4.0'	sw		
		S 3		VERY SOFT, BROWN SILTY CLAY, SOME FINE SAND - MOIST	cl		
	7.5	S 4		VERY SOFT, BROWN SILTY CLAY, SOME FINE SAND - MOIST	cl	WOH	
2.3	10.0	S 5		MEDIUM STIFF, RED CLAY, TRACE LITHIFIED MICACEOUS SHALE - MOIST	cl		
				BOTTOM OF BORING 10.0'			

PROJECT NO. 501003

BORING NO. MW-13
SHEET 1 OF 1

DATE BEGAN: 6-3-86
DATE FINISHED: 6-4-86
GROUND SURFACE EL.: 13.35'

BORING NO. MW-14

N ______ E ______

FIELD ENGINEER: G. H. & D. H.
CHECKED BY: D. HOLZMAN

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U.S.C.S.	REMARKS
6-4-86 (water level)	0–2.0	S 1	ASPHALT WITH CRUSHED GRAVEL BASE BASE) 0.25' FILL: (VERY DENSE, DARK BROWN TO BLACK SILTY SAND, SOME BRICK FRAGMENTS) 2.0'	sm	
10.0	2.5	S 2	MEDIUM DENSE, BLACK SILTY SAND, SOME GRAVEL – MOIST 3.0'	sm	
			MEDIUM DENSE, REDDISH BROWN MEDIUM SAND – MOIST	sp	
	5.0				NO SAMPLE COLLECTED FROM 4' TO 6'.
	7.5	S 3	MEDIUM DENSE, REDDISH BROWN MEDIUM SAND – MOIST 7.5'	sp	
				cl	
	10.0	S 4	MEDIUM STIFF, REDDISH BROWN CLAY, SOME SHALE FRAGMENTS – MOIST	cl	DRILLING OPERATIONS TEMPORARILY ENDED ON 6-3-86 TO SEAT 12" PVC PIPE.
0.0	12.5–15.0	S 5	MEDIUM STIFF, REDDISH BROWN CLAY, TRACE SHALE FRAGMENTS AND BLACK ORGANICS – MOIST	cl	
	17.5	S 6	MEDIUM STIFF, RED CLAY – MOIST 19.5'	cl	
−10.0	20.0–25.0	S 7	MEDIUM DENSE, REDDISH BROWN FINE TO COARSE SAND, SOME FINE GRAVEL – MOIST	sp	

PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50

PROJECT NO. 501003

BORING NO. MW-14
SHEET 1 OF 2

DATE BEGAN: 6-3-86
DATE FINISHED: 6-4-86
GROUND SURFACE EL.: 13.35'

BORING NO. MW-14

N ______ E ______

FIELD ENGINEER: G. H. & D. H.
CHECKED BY: D. HOLZMAN

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	REMARKS
	27.5	S 8		VERY DENSE, REDDISH BROWN FINE TO COARSE SAND, SOME FINE GRAVEL - MOIST	sp		
	30.0						
-18.65	32.0	S 9		VERY DENSE, REDDISH BROWN FINE TO COARSE SAND, TRACE FINE TO COARSE GRAVEL - MOIST	sp		
				BOTTOM OF BORING 32.0'			

PROJECT NO. 501003

DATE BEGAN: 6-5-86
DATE FINISHED: 6-5-86
GROUND SURFACE EL: 9.5'

BORING NO. MW-15

N ______ E ______

FIELD ENGINEER: G. H. & D. H.
CHECKED BY: D. HOLZMAN

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	REMARKS
	0–2.5	S 1		FILL: (SOFT, RED CLAY, SOME CINDERS AND ASH - MOIST)	cl		
	2.5–5.0	S 2			cl		
				4.5'	cl		NO SAMPLE COLLECTED FROM 4' TO 6'.
	5.0–7.5			MEDIUM STIFF, RED CLAY; SOME SHALE FRAGMENTS - DRY	cl		
1.5	7.5–8.0	S 3					
				BOTTOM OF BORING 8.0'			

PROJECT NO. 501003

BORING NO. MW-15
SHEET 1 OF 1

DATE BEGAN: 6-3-86
DATE FINISHED: 6-4-86
GROUND SURFACE EL: 9.8'

BORING NO. MW-16

N ______ E ______

FIELD ENGINEER: G. H. & D. H.
CHECKED BY: D. HOLZMAN

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U.S.C.S.	REMARKS
6-4-86		S 1	FILL: (MEDIUM DENSE, BROWN FINE SAND, SOME GRAVEL - DRY	sp	
	2.5	S 2		sp	PIECES OF WOOD ENCOUNTERED AT ~2.5'.
	3.5'				
	5.0	S 3	FILL: (LOOSE, BLACK COARSE TO MEDIUM SAND, SOME SILT, FINE GRAVEL AND BRICK FRAGMENTS - MOIST)	sp	
	7.0'	S 4			
	7.5		VERY LOOSE, BLACK SILT, SOME FINE GRAVEL - MOIST	ml	
	7.5'	S	VERY SOFT TO SOFT, BROWN PEAT, SOME CLAY - MOIST	pt	
		5		pt	
0.0	9.5' / 10.0		VERY SOFT, BROWN TO RED SILTY CLAY - MOIST	cl	
		S 6	SOFT, RED CLAY,, SOME SILT AND FINE SHALE FRAGMENTS - MOIST	cl	
	12.5	S 7	MEDIUM STIFF, RED CLAY, SOME SHALE FRAGMENTS - DRY	cl	
	15.0				DRILLING OPERATIONS TEMPORARILY ENDED ON 6-3-86 TO SEAT 12" PVC PIPE.
	17.5				
	18.5'				
-10.0	20.0	S 8		sw	
	22.5		VERY DENSE, BROWN FINE TO COARSE SAND, TRACE FINE TO COARSE GRAVEL - MOIST		
	25.0	S		sw	

PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50

PROJECT NO. 501003

BORING NO. MW-16
SHEET 1 OF 2

DATE BEGAN: 6-3-86
DATE FINISHED: 6-4-86
GROUND SURFACE EL: 9.8'

BORING NO. MW-16

N ______ E ______

FIELD ENGINEER: G. H. & D. H.
CHECKED BY: D. HOLZMAN

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	REMARKS
	27.5	9		DENSE, BROWN FINE TO COARSE SAND, TRACE FINE TO COARSE GRAVEL - MOIST	SW		
-20.0	30.0	S					
-21.2	31.0	10			SW		
				BOTTOM OF BORING 31.0'			

PROJECT NO. 501003

BORING NO. MW-16
SHEET 2 OF 2

DATE BEGAN: 6-4-86
DATE FINISHED: 6-4-86
GROUND SURFACE EL.: 9.6'

BORING NO. MW-17

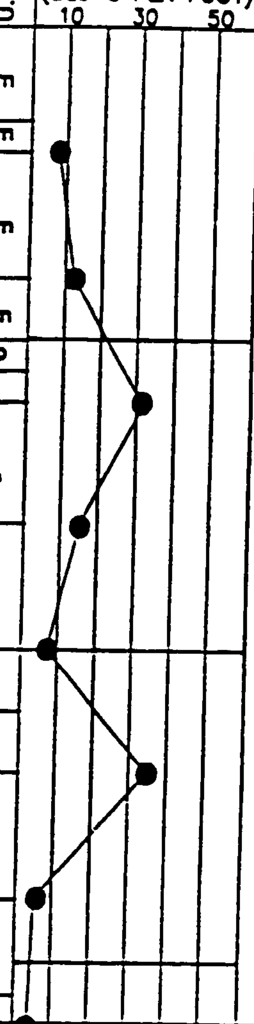
N ______ E ______

FIELD ENGINEER: G. H. & D. H.
CHECKED BY: D. HOLZMAN

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U.S.C.S.
6-4-86		S / 1	FILL: (LOOSE, BROWN SILTY FINE SAND, TRACE CLAY - MOIST) 1.5'	sm
			FILL: (LOOSE, BROWN COARSE GRAVEL, SOME FINE SAND - MOIST) 2.0'	gm
	2.5	S / 2	FILL: (MEDIUM DENSE, BROWN SILTY FINE SAND, TRACE CLAY - MOIST)	sm
	5.0	S	FILL: (MEDIUM DENSE, BROWN SILTY FINE SAND - MOIST) 5.0'	sm
		3	FILL: (MEDIUM DENSE, BLACK MEDIUM SAND - MOIST) 5.5'	sp
			FILL: (MEDIUM STIFF, DARK BROWN SILTY CLAY, TRACE ORGANICS - MOIST) 6.0'	cl
	7.5	S / 4	FILL: (MEDIUM DENSE, BLACK FINE TO MEDIUM SAND - MOIST	sp
0.0	10.0	S / 5	FILL: (VERY DENSE, BLACK FINE TO MEDIUM SAND, SOME BRICK, METAL AND WOOD FRAGMENTS - MOIST)	sp
		S / 6	FILL: (LOOSE, BLACK FINE TO MEDIUM SAND, SOME COARSE GRAVEL AND WOOD FRAGMENTS - WET) 11.0'	sp
	12.5	S / 7	SOFT, BROWN PEAT, SOME CLAY - MOIST	pt
	15.0	S / 8	SOFT, BROWN PEAT - MOIST 15.5'	pt
-6.4	16.0		SOFT, BROWN CLAY - MOIST	cl

BOTTOM OF BORING
16.0'

PENETRATION RESISTANCE (BLOWS PER FOOT)



REMARKS

PROJECT NO. 501003

BORING NO. MW-17
SHEET 1 OF 1

REFERENCE NO. 15

GEOLOGY AND GROUND-WATER RESOURCES OF UNION COUNTY, NEW JERSEY

By Bronius Nemickas

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 76-73

Prepared in cooperation with

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION, DIVISION OF WATER RESOURCES

June 1976

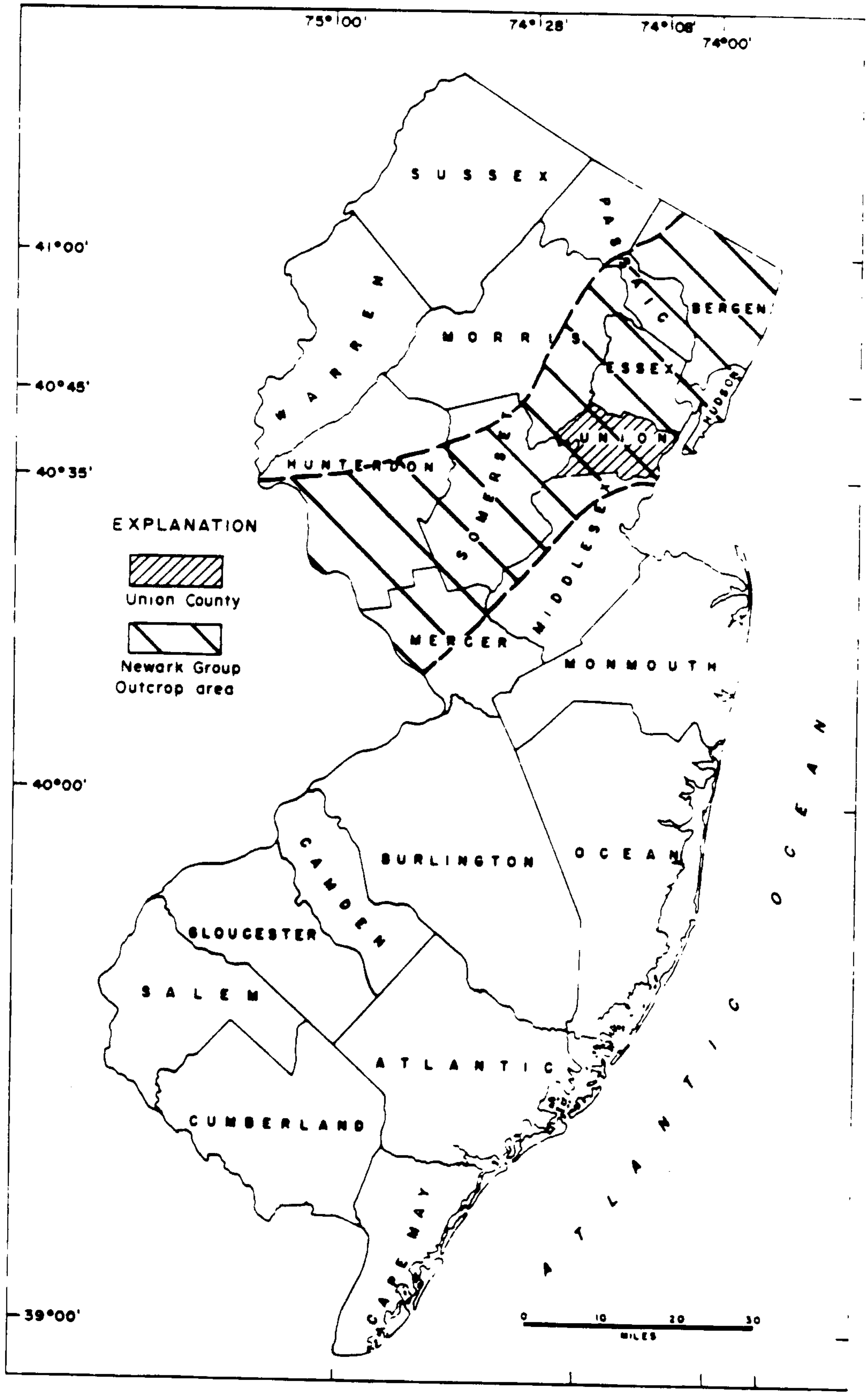


FIGURE 1.--LOCATION OF UNION COUNTY AND OUTCROP AREA OF THE NEWARK GROUP.

Methods of this Investigation

An inventory was made of public, industrial and domestic wells tapping the Brunswick Formation, Watchung Basalt and Pleistocene deposits. The well records are presented in Table 4 and well locations are shown in figure 2.

Geologic information was obtained from drillers' well logs and representative well logs are given in Table 6. A bedrock map on top of the Brunswick Formation and Watchung Basalt was constructed from well log information and is shown in figure 2. The thickness of the Pleistocene deposits can be determined from figure 2 by subtracting the bedrock elevation from the surface elevation.

Chemical analyses of ground water were made to identify the characteristic chemical and physical properties of the ground water in Union County. The chemical analyses of water samples from 59 wells are presented in Table 5 and their location is shown on figure 2.

Acknowledgments

The author wishes to thank well drillers, State, municipal, and industrial officials, and private individuals who supplied data on which this report is based. Acknowledgment is made for the records and logs of wells that were furnished from the files of the New Jersey Bureau of Geology and Topography and to Elizabethtown Water Company for making the water quality analysis available to the author. The cooperation of many individuals who permitted the use of their wells for water-level observation and collection of water samples is gratefully acknowledged.

GEOGRAPHY

Topography and Drainage

Union County is in the Piedmont Plateau, one of eight major physiographic divisions of the United States. The major topographic features of the Piedmont Plateau in Union County are: (1) the Watchung Mountains, two basaltic ridges with maximum altitudes of about 550 feet, trending parallel to the northwestern boundary of the county; and (2) a gently rolling plain sloping from about 100 to 150 feet at the eastern side of the Watchung Mountains to sea level at Arthur Kill.

The Watchung Mountains extend from Passaic County through Essex and Union Counties and terminate in Somerset County. The ridges are underlain by thick sheets of basaltic lava flows intercalated with the shales and sandstones of the Newark Group. These ridges trend generally northeast-southwest and have steep, rock escarpments on the east and gentle slopes on the west.

Industrial Products	Number of Establishments
Chemicals and allied products	104
Fabricated metal products	226
Machinery, except electrical	275
Food and kindred products	71
Miscellaneous manufacturing	77
Printing and publishing	113
Furniture and fixtures	34
Instruments and related products	25
Textile mill products	14
Stone, clay, and glass products	26
Rubber and plastics products	63
Total	1,424

(New Jersey Department of Environmental Protection, 1967)

GEOLOGY

Newark Group

During the Late Triassic Epoch downfaulting produced a series of northeast-southwest trending basins in the Piedmont Plateau from Nova Scotia to North Carolina. Sedimentary and associated igneous rocks of Triassic age occupy the downfaulted basins and are known as the Newark Group. In New Jersey the Newark Group crops out in a band 16 to 30 miles wide trending northeast-southwest from the Delaware River to the Hudson River (fig. 1). Union County lies entirely within this band.

The Newark Group in New Jersey contains 15,000 to 20,000 feet of non-marine shales, mudstones, sandstones, conglomerates, and basic igneous rocks that unconformably overlie rocks of Paleozoic and Precambrian age. The sedimentary rocks of the Newark Group were largely derived from Paleozoic and Precambrian rocks to the southeast and deposited in a non-marine intermontane basin (Van Houten, 1965). During Triassic time the sedimentary rocks were intruded by a diabase sill, dikes, and covered by several flows of basalt.

The Newark Group underlying Union County consists of the Brunswick Formation and Watchung Basalt. The generalized geologic map (fig. 4) shows the areal distribution of the Triassic rocks underlying Union County. Figure 5 is a generalized section showing the geology and structure of Union County.

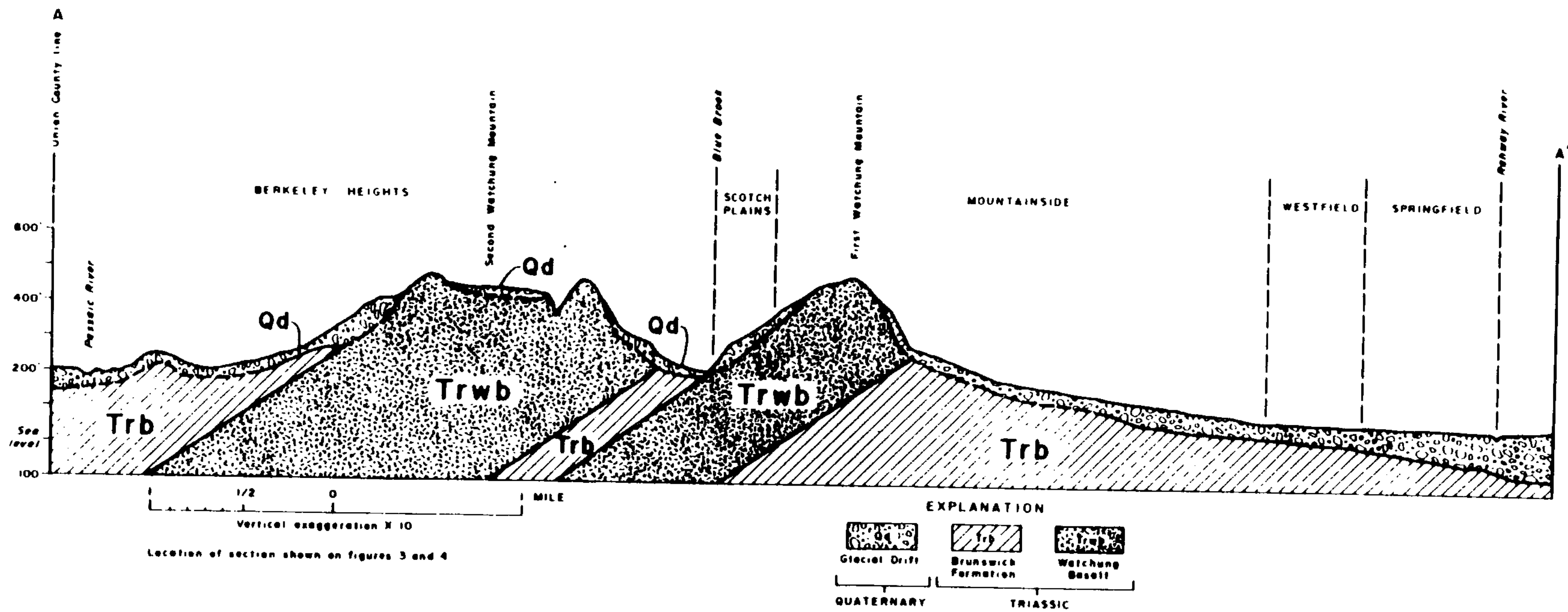


FIGURE 5.--GENERALIZED GEOLOGIC SECTION ACROSS UNION COUNTY, NEW JERSEY.

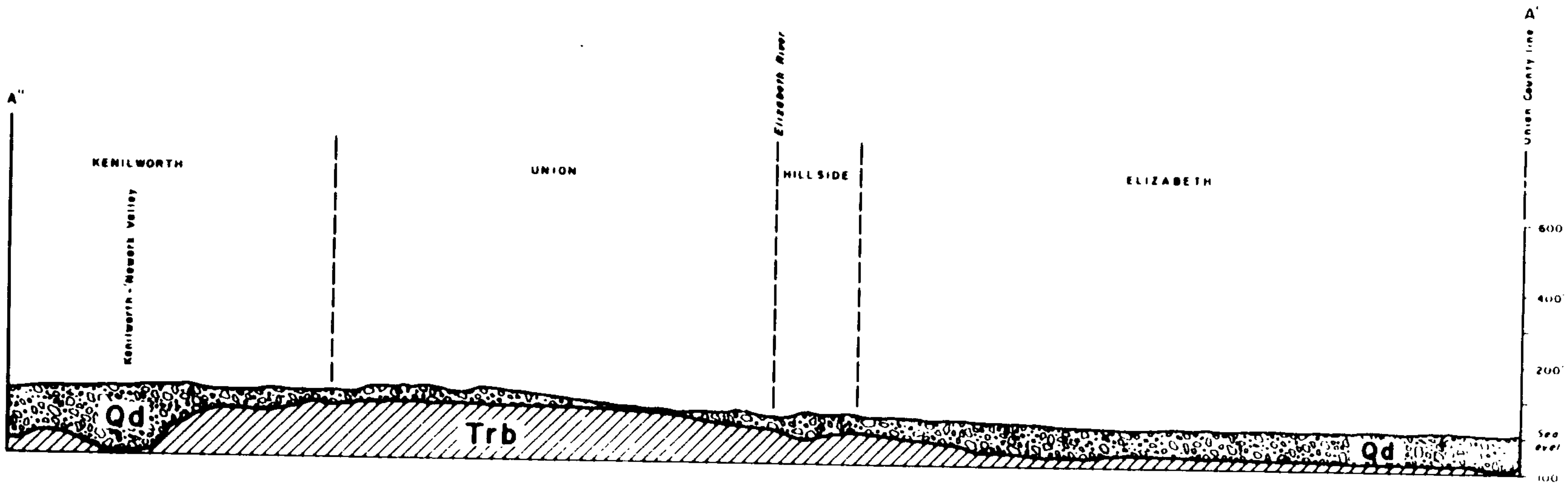


FIGURE 5.--CONTINUED

The Brunswick Formation consists of thin-bedded shales, mudstones, and sandstones which range in color from reddish-brown to gray. The reddish-brown color originates from reworked hematite which comprises 5 to 10 percent of the formation (Boch, 1959). The minerals of the Brunswick Formation include quartz, illite, muscovite, feldspar, and small amounts of calcite and gypsum. Primary structures such as ripple marks and mud cracks indicate that the Brunswick Formation was deposited in a shallow-water environment.

The regional strike of the Brunswick Formation in Union County is N50°E with dips 9° to 13°NW. The major joint sets strike approximately N45°E and N75°W and both sets have a vertical dip. The thickness of the formation is 6,000 to 8,000 feet.

The Watchung Basalt consists of three extensive basaltic lava sheets that are intercalated with the sedimentary rocks of the Brunswick Formation. The basalt flows are more resistant to erosion than the shales, mudstones, and sandstones and form prominent ridges. Two of the three lava sheets occur in Union County and form the First and Second Watchung Mountains. The third sheet forms a discontinuous ridge known as Long Hill and Hook Mountain in Morris County to the west of Union County.

The basalt flows are volcanic extrusive rocks which were formed by the outflow of lava onto the land surface. Rapid cooling of the flows produced a dense, aphanitic rock. Phenocrysts are present in the ground mass which give the basalt a porphyritic texture. The phenocrysts are usually augite and in some cases feldspar. The ground mass for the most part consists of augite and feldspar.

The basalt sheets vary in thickness from less than 300 feet in parts of the Long Hill flow to a maximum of about 1,200 feet in parts of the Second Watchung Mountain. The Second Watchung Mountain is a double flow sheet separated by a thin section of the Brunswick Formation. The thickest flow sheet is the upper flow of the Second Watchung Mountain which has a maximum thickness of about 800 feet.

Quaternary Deposits

Unconsolidated sediments deposited by glaciers or by glacial meltwater during the Pleistocene Epoch mantle the bedrock surface in Union County. These deposits consist of clay, silt, sand, gravel, and boulders. They are glacial, glaciolacustrine (deposited by glacial meltwater in lakes), or glacial fluvial (deposited by glacial meltwater in streams) in origin.

The Pleistocene sediments fall into three general classes: (1) end moraine--a moraine jointed across the course of a glacier at its farthest advance; (2) ground moraine--the material carried forward in and beneath the ice and finally deposited from its under surface; and (3) stratified drift--deposits from glacial meltwater exhibiting both sorting and stratification. The stratified drift includes lacustrine (deposited in lakes) and fluviatile (deposited in streams) sands and clays.

Figure 3 is a surficial geologic map of Union County showing the extent of the end moraine, ground moraine, and stratified drift. West of the end moraine near Scotch Plains and Plainfield, stratified drift forms an outwash plain (fig. 3).

Before the last glaciation the rivers draining Union County cut deep valleys into the Brunswick Formation (fig. 2). Subsequently the valleys were filled and buried by glacial material. The thickness of the glacial deposits is controlled largely by the underlying bedrock topography. Figure 6 consists of three sections showing the altitudes of the bedrock valley floor and thickness of Pleistocene deposits in the bedrock valleys. These buried channels underlie parts of Hillside, Union, Springfield, Clark, and Scotch Plains Townships, and the Boroughs of Mountainside, New Providence and Kenilworth and the Cities of Summit and Rahway.

The Pleistocene sediments in the bedrock channels consist of unstratified and stratified clay, silt, sand, and gravel. Only the sand and gravel deposits of the stratified drift will yield large quantities of water to wells.

Deposits of Holocene (Recent) age cover only small areas and include river alluvium, and eolian deposits.

The stratigraphic units in Union County and their geologic and hydrologic characteristics are given in Table 1. Table 6 contains representative well logs indicating the variations in the lithologies of the geologic units.

GROUND WATER HYDROLOGY

Introduction

Water is continually being exchanged in a circulatory pattern between the earth and the atmosphere. In general, the amount of precipitation ultimately determines the amount of water available for man's use. Some of the precipitation that falls on land evaporates where it falls, some is absorbed by plants that later transpire the water back to the atmosphere, some flows overland to streams, and some infiltrates into the ground to become ground water. The ground water is discharged to streams, and streams flow to the oceans where the water can be evaporated back to the atmosphere.

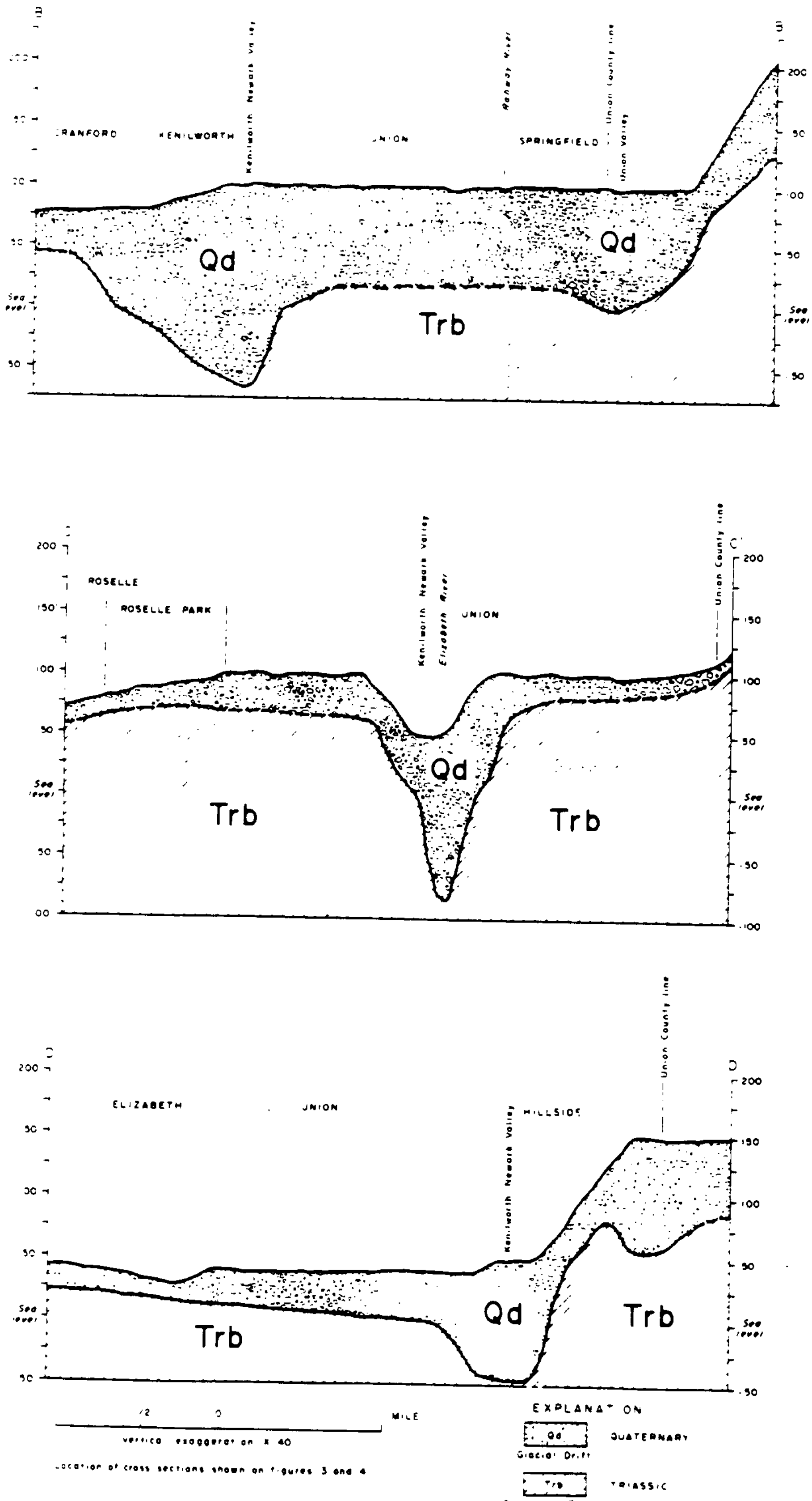


FIGURE 5.--GEOLOGIC SECTIONS SHOWING THE BURIED CHANNELS IN UNION COUNTY, NEW JERSEY.

Table 1.--Geology and hydrology of the rock units in Union County, New Jersey

Era	Period	Series	Formation or lithologic unit	Thickness (feet)	Lithology	Hydrologic characteristics
Cenozoic	Quaternary	Holocene	alluvium	0-25	Sand, silt, and mud in and along river channels.	Relatively impermeable deposits; retard intrusion of saline water through river beds.
			eolian deposits	0-10	Sand	Above water table; high rate of infiltration.
		Pleistocene	un-stratified drift (till)	0-200	Unstratified clay, sand and gravel; reddish brown in color. Forms the ground and end moraine deposits. Deposited by glaciers.	Because of low permeability, it is not an important aquifer in the County.
			stratified drift	0-60	Sand and gravel lenses which are stratified. Occurs as lenses in the till in the bedrock channels and inter-bedded with till in the end moraines. Deposited by water.	Important as an aquifer in the City of Rahway and in Union, Hillside and Springfield Townships and in Kenilworth Borough. At the City of Rahway and Hillside Township wells induce recharge from rivers.
					Unconformity	
Mesozoic	Triassic	Upper Triassic	Newark Group: Brunswick Formation	6,000-8,000	Interbedded, soft red shales, mudstones, and sandstones. Adjacent to the Watchung Basalt it is altered to a hornfels.	Most extensive and most important aquifer in Union County. Water stored in and transmitted along fracture and joint systems which decrease in number and volume with depth. Both artesian and water-table conditions exist.
			Newark Group: Watchung Basalt	300-800	Basaltic lava sheets inter-calated with the sedimentary rocks of the Newark Group. Two of the sheets crop out in Union County. The basalt is a dense, aphanitic, extrusive rock. Augite and feldspars are the chief minerals.	Minor aquifer in the county. Well yields are low to moderate.

The hydrograph of the Hillside well No. 27 (fig. 7B) shows seasonal water level fluctuations due to pumpage in the area. The general lowering of water levels from 1953 to 1961 is a result of increased pumpage. The increased rate of water level decline from 1961 to 1965 is also attributed largely to below-average precipitation. Hydrographs of the remaining six observation wells in Union County show no significant decline in water levels during the period 1956 to 1968. The hydrograph (fig. 7C) of one of these wells tapping the Brunswick Formation, Elizabeth No. 1, shows a rise in water levels from about 1963 to 1968. This rise is believed to be the result of decreased pumpage from nearby wells. However, no data are available to indicate such changes in pumpage.

The water table generally rises from the end of October to the middle of April, a period when evapotranspiration is at its lowest (fig. 8). The decline of water levels as shown by the hydrograph of Kenilworth well No. 4 indicates that discharge exceeds recharge from April through October when evapotranspiration is at its highest (fig. 8). The ground-water level decline is accompanied by decreasing stream runoff (fig. 8). The decline in stream runoff is partly controlled by the decreasing water-table gradient. The decrease in overland flow to streams in spring and summer also decreases total runoff, because most of the precipitation either evaporates or infiltrates the soil, where it is transpired by plants.

Hydrologic Properties of Rocks

Porosity is the ratio of the volume of pore space in a rock to its total volume and is expressed as a percentage. Porosity includes both primary openings such as intergranular pore space in the Pleistocene deposits and secondary openings such as joints and fractures in the Brunswick Formation and Watchung Basalt.

The permeability of a rock is its capacity to transmit water. The coefficient of permeability is the rate of flow of water, in gallons per day through a cross-sectional area of 1 square foot under a hydraulic gradient of 1 foot per foot at a temperature of 60°F.

The coefficient of transmissibility of an aquifer is the rate of flow of water, at the prevailing water temperature, in gallons per day, through a vertical strip of the aquifer 1 foot wide extending the full saturated height of the aquifer under a hydraulic gradient of 100 percent.

The storage coefficient of an aquifer is the volume of water in cubic feet discharged from each vertical column of the aquifer with a base of 1 foot square as the water level falls 1 foot.

In field practice, the coefficient of transmissibility and storage are usually determined by aquifer tests, and the coefficient of permeability is computed by dividing the transmissibility by the saturated aquifer thickness.

The specific capacity of a well, the rate of yield per unit drawdown for some time interval, generally gallons per minute per foot of drawdown, can be a good measure of the transmissibility of the rocks. High specific capacities generally suggest a high coefficient of transmissibility, and low specific capacities generally suggest a low coefficient of transmissibility. However, specific capacity also is affected by the coefficient of storage, the thickness and boundary conditions of the aquifer penetrated by the well, and development and construction of the well.

For a more complete discussion of general ground-water hydraulics, the reader is referred to Theis (1935, p. 519-524), Ferris (1949, p. 226-272), Todd (1959, p. 77-114), DeWiest (1965, p. 161-183), and Davis and DeWiest (1966, p. 156-374).

Water-bearing Properties of Major Rock Units

Newark Group

Brunswick Formation

The Brunswick Formation of Late Triassic age is the major aquifer in Union County and underlies most of the county. Water in this formation occurs in joints and fractures. These joints and fractures become progressively tighter and fewer with increasing depth below land surface. Only moderate quantities of water can be stored or transmitted in these fractures.

Ground water occurs under both unconfined and confined conditions in the Brunswick Formation. Unconfined ground water occurs mainly in the upland areas where overlying unconsolidated sediments are thin or absent. In the lowland areas in the southern and eastern part of Union County the rocks are mantled by unconsolidated Pleistocene deposits that, in most places, contain silt and clay beds. In the lowland areas the silt and clay beds may confine water in the underlying rocks. Wherever such confinement occurs, water beneath the impermeable layers is under artesian pressure. In a few areas the artesian head is above land surface resulting in flowing wells. Locally, artesian conditions result from differences in permeability within the rock layers caused by varying degrees of fracturing, or weathering, or a combination of both.

Several pumping tests have been conducted on wells tapping the Brunswick Formation in Union County. The coefficient of transmissibility determined from five of these tests ranged from 5,900 to 25,400 gpd per ft; most of the values lie between 15,000 and 25,000 gpd per ft. The average coefficient of storage computed from these tests is about 0.00005.

Results of pumping tests indicate that the Brunswick Formation is anistropic; that is, its ability to transmit water is not equal in all directions. The greatest drawdowns caused by pumping are observed in wells aligned along the strike of the beds with respect to the pumping well. The smallest drawdowns are observed in wells aligned transverse to the strike (Vecchioli, 1967). These pumping test observations have been interpreted to indicate that joints and factures which strike parallel to the strike of the bedding are better developed and interconnected than joints and fractures which strike in other directions. Therefore, minimum interference between pumping wells in well fields tapping the Brunswick Formation can be achieved by aligning the wells across the strike of the beds rather than parallel to the strike.

The average reported yield of 230 public-supply, industrial, and commercial wells (table 4) tapping the Brunswick Formation is 200 gpm; yields range from 12 to 870 gpm. A better indication of the potential yield of properly located and developed wells tapping the Brunswick Formation can be obtained from analysis of yields of large diameter (10 inch or greater) wells. The large diameter wells, generally the deeper wells, represent attempts to develop the maximum supply of water. The average yield of 109 large diameter wells (table 4) is 310 gpm; yields range from 23 to 870 gpm.

The distribution of well yields is as follows:

Yield (gpm)	230 Wells	109 Large Diameter Wells
0 - 50	18	2
51 - 100	42	9
101 - 150	36	8
151 - 200	32	14
201 - 250	25	10
251 - 300	20	13
301 - 350	16	15
351 - 400	10	7
401 - 450	6	6
451 - 500	9	9
501 - 550	10	10
551 - 600	2	2
600	4	4

Figure 9 shows the cumulative frequency distribution of reported yields of wells in the Brunswick Formation. It can be seen on the graph that 50 percent of the 230 wells have yields equal to or less than 180 gpm; 50 percent of the large diameter wells have yields equal to or less than 300 gpm. Many of the higher yielding wells occur where the Brunswick Formation is overlain by relatively thick, saturated glacial deposits that readily pass water downward into the fractures in the Brunswick Formation.

The specific capacities of 205 wells (6 to 12 inches in diameter) in the Brunswick Formation range from 0.04 to 25 and average 3.5 gpm per foot of drawdown; 14 of the wells have specific capacities greater than 10 gpm per foot of drawdown. The depths of the wells range from 100 to 1,108 feet and average 387 feet.

Figure 10 is a cumulative frequency distribution graph of specific capacities of wells tapping the Brunswick Formation in Union County. In figure 10, specific capacities are related to the well diameter. The larger diameter wells have the higher specific capacities. Median specific capacities are 1.7 for 6 and 8-inch diameter wells, 2.0 for 10 inch diameter wells and 3.1 for 12 inch and larger diameter wells. The higher specific capacities in the larger diameter wells can be attributed to better well development, well site selection and decreased well entrance losses.

In table 2, specific capacities are listed in percentile on the basis of depth of well drilled below land surface. In order to minimize the effect of well diameter on specific capacity, separate listings for larger and smaller diameter wells are given. Wells between 200 and 600 feet deep, in general have higher specific capacities than wells of shallower or greater depths. This relationship suggests that the best water-producing zones in the Brunswick Formation are encountered between depths of 200 and 600 feet. Below 600 feet the fractures and joints are less enlarged and generally drilling to greater depths will not produce significantly greater well yields.

Wells tapping the Brunswick Formation generally draw water from several water-bearing zones. In areas where the rocks are exposed or covered by a thin layer of unconsolidated sediments the shallow water-bearing zones contain unconfined water to a depth of about 200 or 300 feet. If wells penetrate to depths between 200 and 600 feet one or more confined zones of greater permeability are intercepted. The wells that are drilled between 200 to 600 feet in general have the greatest yields.

Watchung Basalt

The Watchung Basalt is a minor aquifer and underlies the western edge of Union County. In this formation vesicles add primary porosity to the secondary porosity developed from the joints and fractures. However, all these openings constitute only a small part of the total volume of the basalt and their capacity to store and transmit water is poor.

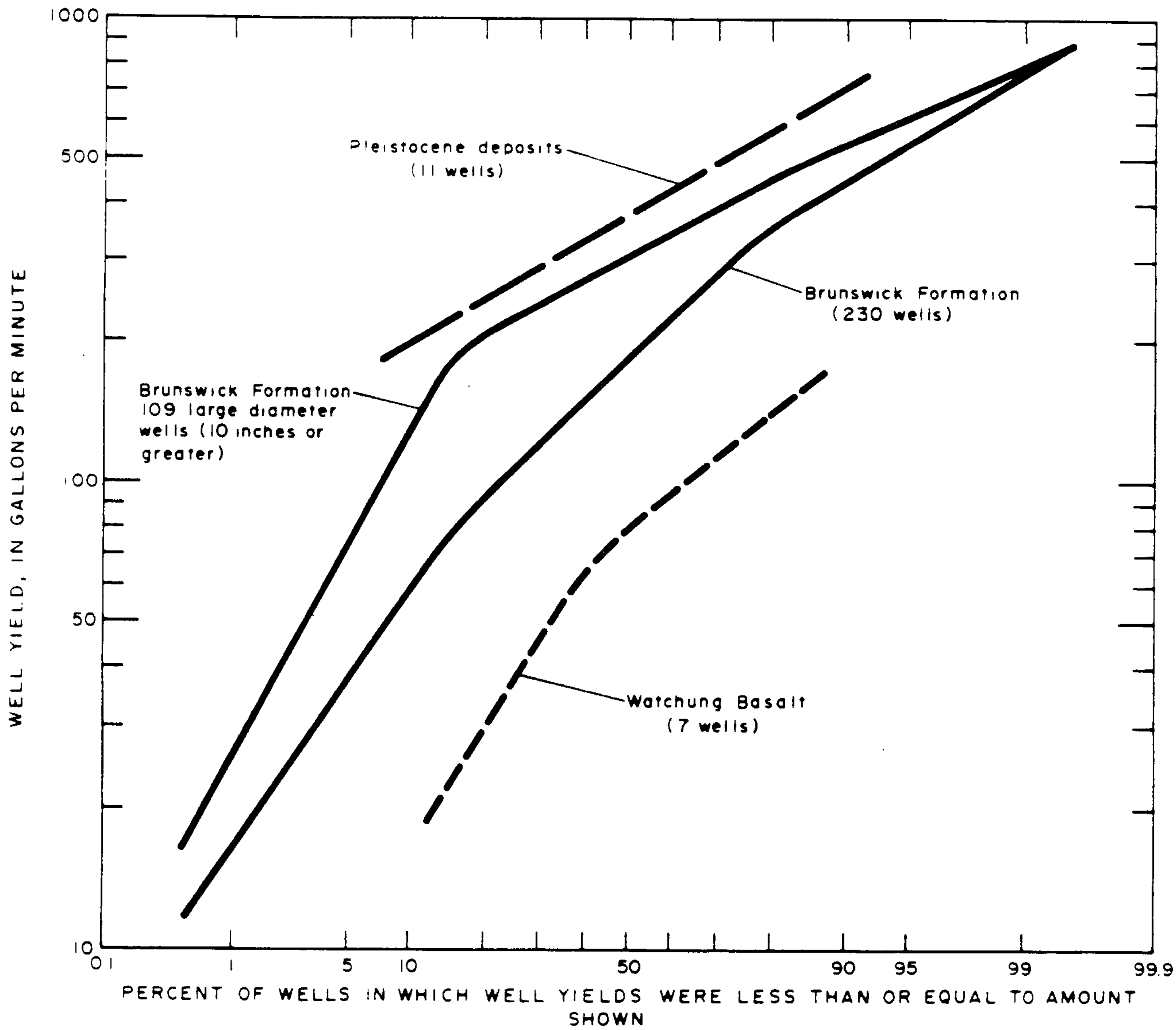


FIGURE 9.--CUMULATIVE FREQUENCY DISTRIBUTION OF YIELDS OF WELLS PENETRATING THE BRUNSWICK FORMATION, WATCHUNG BASALT AND PLEISTOCENE DEPOSITS.

Wells tapping the Watchung Basalt produce small to moderate quantities of water. Reported yields of seven industrial and commercial wells (Table 4) range from 20 to 164 gpm and average 85 gpm. The distribution of the yields is as follows:

Yields (gpm)	Number of Wells
0 - 50	2
51 - 100	3
101 - 150	1
151 - 200	1

It can be seen on the cumulative frequency distribution graph (fig. 9) that 50 percent of the wells have yields equal to or less than 80 gpm.

Specific capacities of the wells in the basalt range from 0.24 to 2.5 and average 1.23 gpm per foot of drawdown.

Pleistocene Deposits

Only sand and gravel aquifers of the stratified drift contain sufficient quantities of water to warrant consideration of their water-bearing properties. The most productive artesian and semi-artesian aquifers of the stratified drift in Union County occur as valley-fill deposits in channels that were cut into the bedrock before the last glaciation.

Areas of greatest thickness of valley-fill material and the altitude of the deepest bedrock valleys are shown below.

Valley	Location	Thickness of valley-fill material (feet)	Altitude of bedrock channel bottom (feet)
Kenilworth-Newark Valley	Newark	230	-220
	Hillside	102	-52
	Union	131	-78
	Kenilworth	180	-90
Summit Valley	Summit-New Providence	223	+17
Union Valley	Union-Springfield	91	-3
Rahway	Rahway	56	-26
	Scotch Plains	70	-10

REFERENCE NO. 16

II. HYDROGEOLOGY OF MIDDLESEX COUNTY

A. Background

Middlesex County lies within two major physiographic provinces - the Atlantic Coastal Plain and the Piedmont Province. That portion of the County west of the Lawrence Brook and north of the Raritan River are generally within the Piedmont Province while the remainder of the County is within the Atlantic Plain. That portion within the Piedmont Province is generally characterized by clay and shale formations with relatively high surface runoff rates while the Coastal Plain is characterized by sand and gravel formations along with a higher infiltration rate. The topography of the County is generally level or rolling with maximum elevations of approximately 240 feet in the southwestern part of South Brunswick Township. The remainder of the County averages some 100 feet in elevation. The lowest elevations approach sea level at the tidal areas on Raritan Bay and at the mouth of the Raritan River. As a result of its natural topography and its proximity to Raritan Bay the County contains numerous natural drainage ways the majority of which drain to the mainstem of the Raritan River and into Raritan Bay. Several streams in the eastern area of the County drain directly to the Raritan Bay and several in the northeastern portion of the County are tributaries of the Rahway River or drain directly to the Arthur Kill (See Figure 1).

Middlesex County's climate is described as temperate with the average annual temperature between 50°F and 55°F. January and February are the coldest months having a mean temperature of 32°F with July the warmest month having a mean temperature of 75°F. Water temperatures follow a similar pattern, also ranging from 32°F to 75°F. Prevailing winds are from the northwest during the winter months and from south to southwest during the warmer months.

The average annual precipitation within the County is approximately 44 inches with February having the lowest monthly average and July the highest. The period from May to September has the highest average rainfall. Annual snowfall averages between 20 and 30 inches. Complete precipitation and temperature data for the New Brunswick meteorological station are shown in Table 2 on the following page.

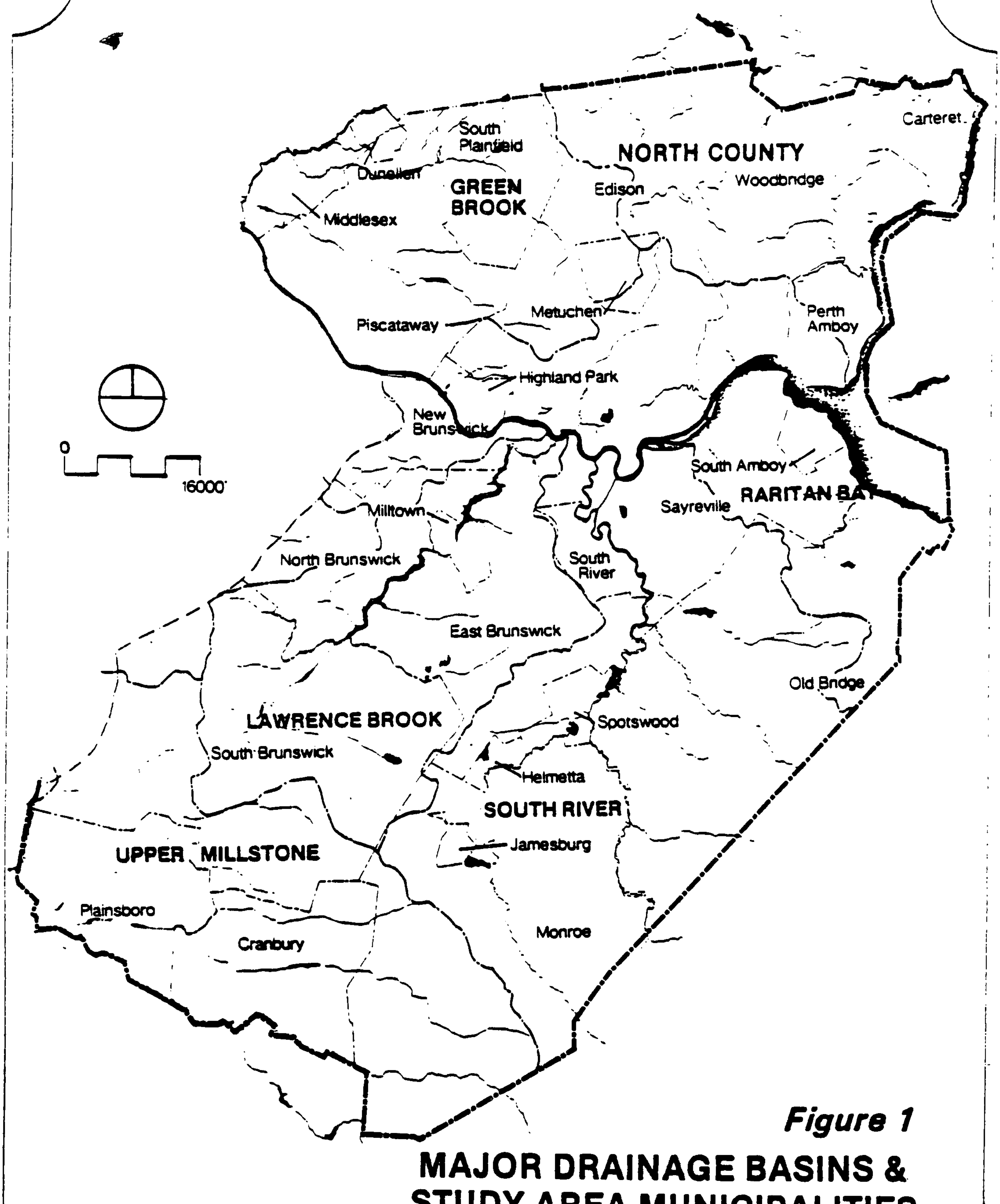


Figure 1

MAJOR DRAINAGE BASINS & STUDY AREA MUNICIPALITIES

TABLE 2

Average Precipitation and Temperature
At New Brunswick, N.J.

Month	Precipitation[1] (inches)	Temperature[2] °F
January	3.25	31.2
February	2.96	32.8
March	3.59	40.6
April	3.47	51.6
May	3.77	61.4
June	3.67	70.2
July	4.89	74.9
August	4.73	73.1
September	3.68	66.7
October	3.22	56.5
November	3.16	45.6
December	3.26	33.9
Annual Average	43.65	53.2°

B. Hydrogeology

Geologic sequence in Middlesex County is listed in Table 3 with those formations which are both sufficiently thick and important County water supply sources highlighted. A generalized northwest-southeast cross section from the Stelton to Runyon areas shown in Figure 2.

The areal extent of major aquifer recharge areas in Middlesex County have been identified in Figure 3. These are the locations where water bearing geologic formations are at the surface or have a water permeable ground cover. These recharge or outcrop areas provide the majority of the water to the wells drilled to the aquifers. It is estimated that there are more than eight thousand wells tapping groundwater in Middlesex County. The largest majority of these wells are of low capacity and are used primarily for domestic purposes, however, 293 wells can each produce at least 100,000 gallons per day[3].

The two distinct aquifer formations that provide the largest portion of the groundwater in Middlesex County are the unconsolidated sand and gravel of Upper Cretaceous Age and the consolidated rocks of Triassic Age. The principal sources of groundwater in order of their importance are: the Old Bridge Sand and Farrington Sand aquifers of the Raritan Formation, the Brunswick shale of Newark Group (Triassic formation) and the Undifferentiated Sands of Upper Cretaceous Age. Although more water is drawn from the Newark Group than from the Undifferentiated Sands and Englishtown Sand, Newark Group rocks are not as uniformaly reliable as the Cretaceous Sand.

A detailed discussion of the geologic and hydrologic characteristics of each strata is provided in the report by Henry C. Barksdale et. al[4]. In

TABLE 3

Hydrostratigraphic Sequence in Middlesex County[5]

Cenozoic Sequence
  Quarternary System
    Recent Series
      Alluvium
      Eolin deposits
    Pleistocene series
      Wisconsin drift
      Cape May formation
      Pensauken formation

Unconformity

Mesozoic Sequence
  Cretaceous System
    Upper Cretaceous series
      Mount Laurel and Wenonah Sands
      Marshalltown formation
      Englishtown sand
      Woodbury clay
      Merchantville clay
      Magothy formation
      Raritan formation
        Amboy stoneware clay
        Old Bridge sand
        South Amboy fire-clay
        Sayreville sand
        Woodbridge clay
        Farrington sand
        Raritan fire-clay

Unconformity

Triassic System
  Upper Triassic series (Newark group)
    Brunswick shale
    Lockatong formation
    Stockton formation

Unconformity

Proterozoic Sequence
  Pre-Cambrian
    Wissahickon formation

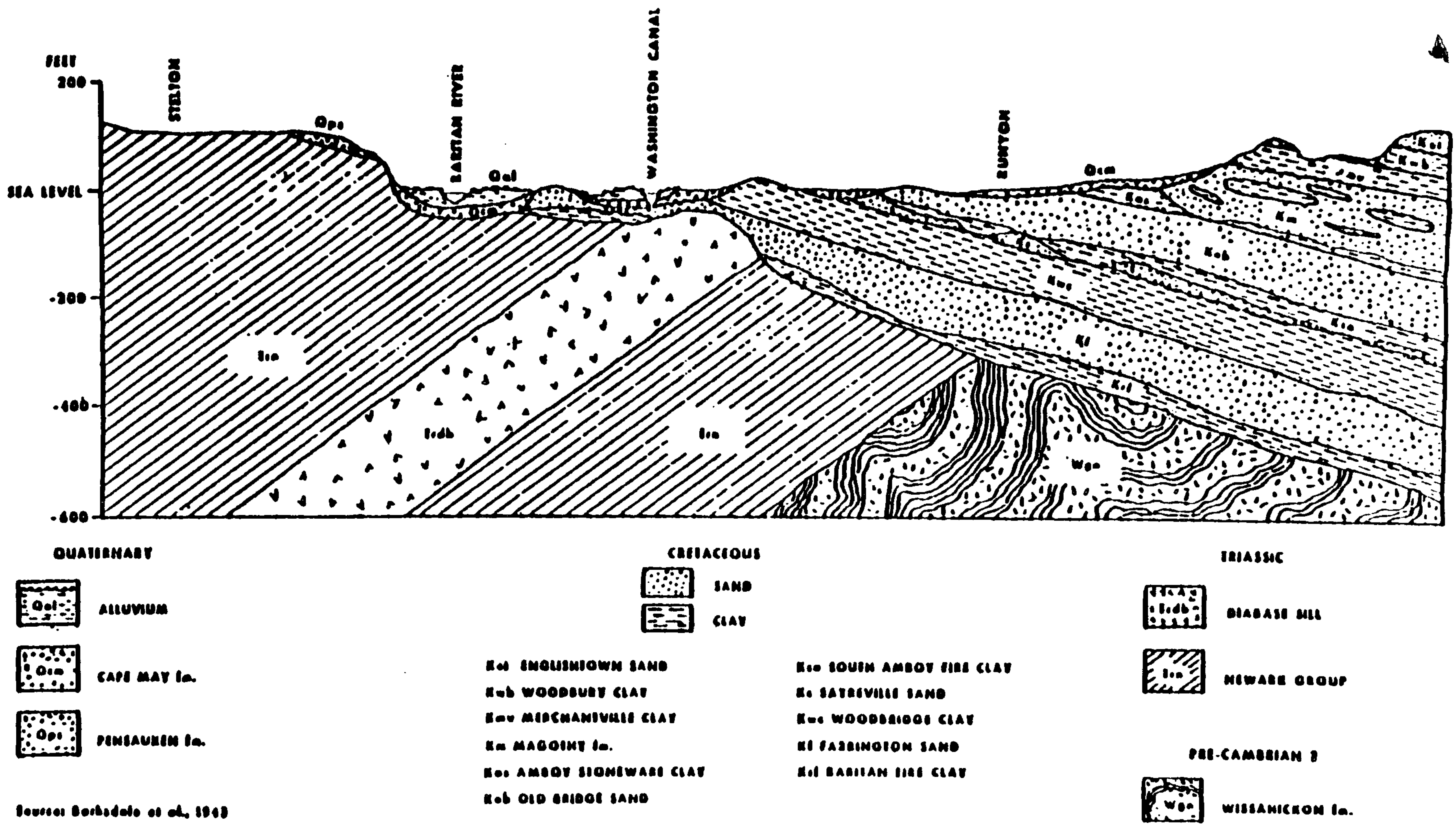


Figure 2

GENERALIZED GEOLOGIC SECTION - Middlesex County

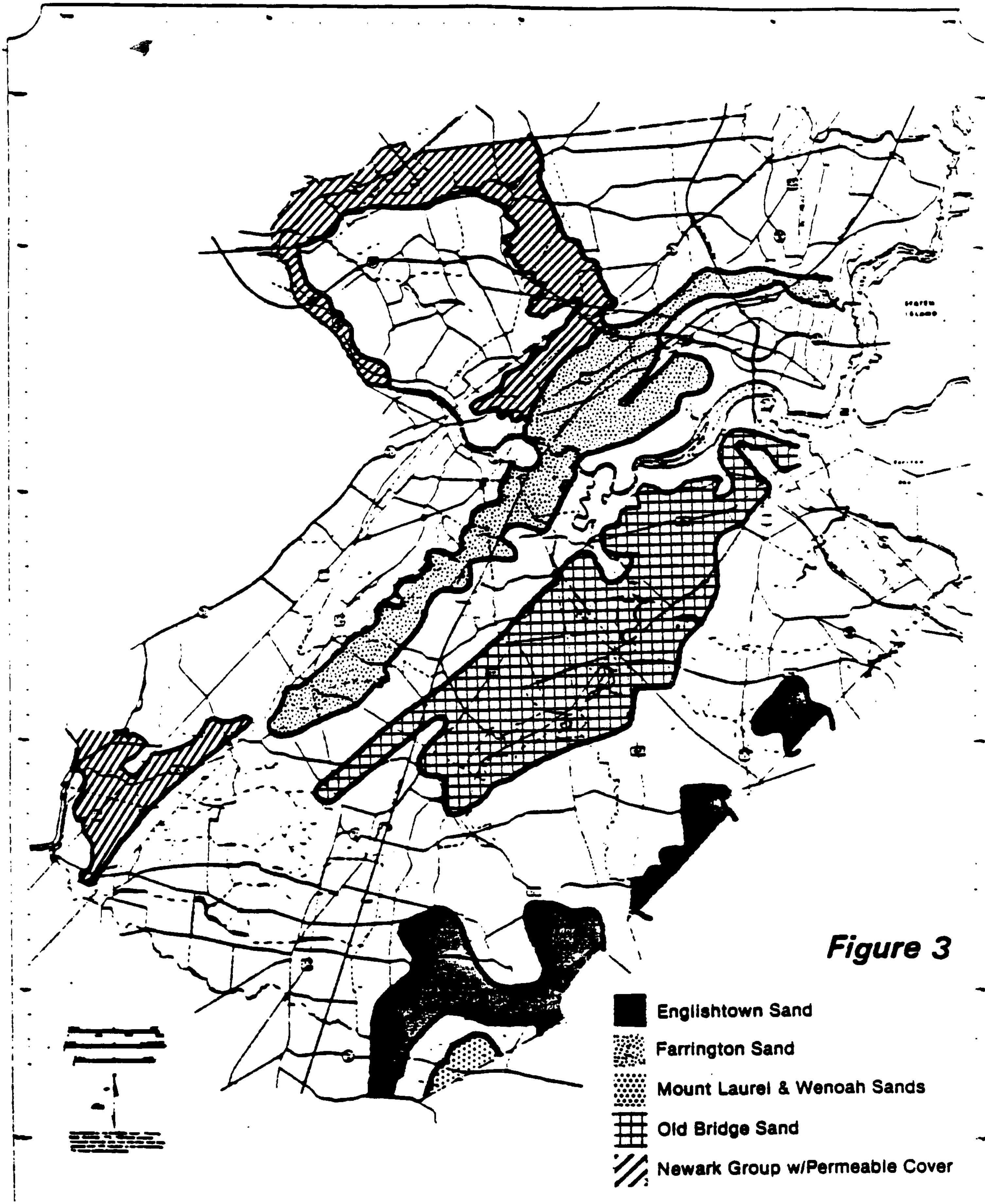
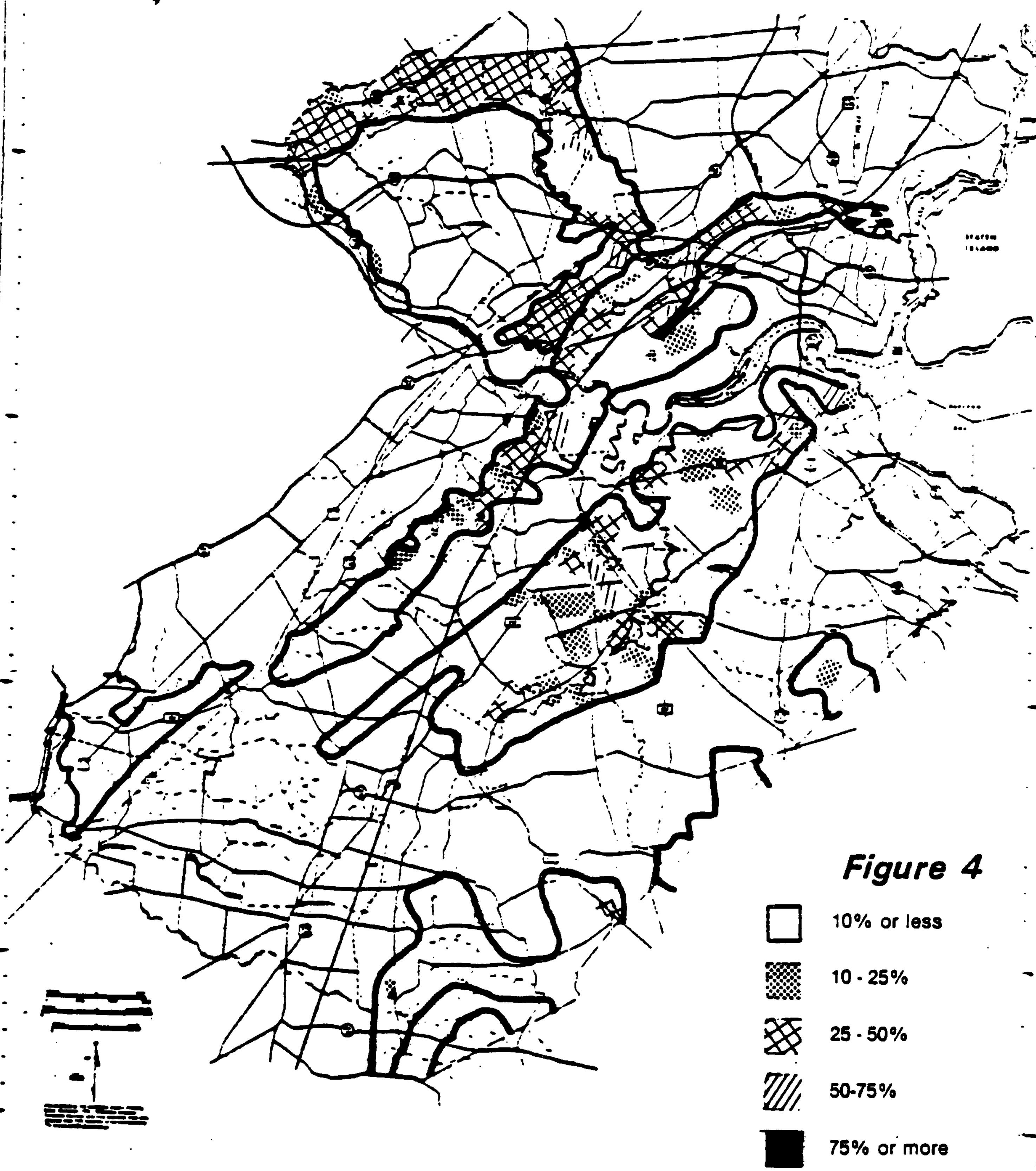


Figure 3

AQUIFER RECHARGE AREAS



DEVELOPMENT WITHIN AQUIFER RECHARGE AREAS 1973 this study an attempt has been made to evaluate and summarize the geologic characteristics of the rocks as they relate to their water carrying and water producing capacity.

C. Quarternary System

1. Wisconsin Drift

The Wisconsin Drift was deposited by the last four continental ice sheets of the Pliestoncene Age which covered large portions of the northern United States. It forms a nearly continuous mantle over the underlying Triassic and Cretaceous rocks in the northeastern part of Middlesex County. The southern limit reached by the Wisconsin glacier in Middlesex County is roughly along a line from Plainfield to Metuchen and over to the mouth of the Raritan River at Perth Amboy.[8] The Wisconsin Drift is of importance from a water supply standpoint primarily because some portions are permeable enough to absorb water directly from precipitation and transmit it readily into underlying beds.

The outwash plain found between Metuchen, Plainfield and east Bound Brook covers an estimated 16 square miles and consists of layers of sand and gravel which together are called stratified drift. The stratified drift is approximately 10 to 60 feet thick on the eastern edge near the moraine. In general the stratified drift is quite permeable but it is too shallow and covers too small an area to be in itself an important water supply source. However, it holds water which percolates into the underlying Brunswick formation and has increased the yield of many wells located on the drift.[9]

2. Cape May Formation

The Cape May formation is a pinkish-yellow fine to medium grained quartz sand forming a thin mantle 3 to 10 feet thick over the Cretaceous formation in the South River valley as well as along the south shore of the Raritan River.

The average porosity of the Cape May formation is 43% and the average specific yield is 38%. The coefficient of permeability ranges between 180 to 900 with a weighted average of 450. A block of Cape May Sand one square mile in area and one foot thick is capable of storing approximately 80 million gallons of water.[10]

The important hydrologic feature of the Cape May formation is that it overlies the Old Bridge Sand aquifer and increases its recharge capacity. No major water supplies are drawn directly from the Cape May formation at the present time.

3. Pensauken Formation

In the southern portion of Middlesex County most of the hills and upland areas (above 60 feet elevation) are covered with a layer of yellow to brown, clayey sand and gravel known as the Pensauken formation. The largest area is between the Lawrence Brook and South River extending southwest to Cranbury. The Pensauken formation in this area is of importance in that it covers the truncated sand members of the Raritan formation.

The Pensauken formation ranges in thickness to 70 feet with the average porosity and specific yield estimated to be 40% and 30% respectively. The coefficient of permeability is considerably less than the Cape May formation, ranging between 120 and 200 and averages approximately 170. A block of the Pensauken formation 1 square mile in area and 1 foot thick could store an estimated 64 million gallons of available water.

No large water supplies have been developed from the Pensauken formation however it does yield small supplies of water to a large number of wells for domestic and farm use. Its importance from an hydrologic standpoint is in that it readily absorbs water from precipitation and transmits it to underlying aquifers resulting in an increase in the effective recharge area. Much of the intake area of the Farrington Sand and a portion of the intake area of the Old Bridge Sand is overlain by the Pensauken formation.

D. Cretaceous System

1. Englishtown Sand

The Englishtown Sand occurs near the southeastern border of the County and is a fine to medium-grained white or yellow sand which is occasionally micaceous, lignitic and limonitic. The Englishtown Sand in Middlesex County is approximately 100 feet thick and is overlain by the relatively impermeable Marshalltown formation.

Physical properties of the formation vary widely. The weighted average coefficient of permeability is 525 with the average porosity 44% and specific yield 30%. On the basis of the physical properties and the performance of wells tapping this resource in Monmouth County, the Englishtown Sand is in all probability the third most productive Coastal Plain in Middlesex County. At the present time however, no large water supplies have been developed from this formation in Middlesex County because of its relatively remote location from population and industrial centers. It should be noted that the Englishtown Sand is the second major source of water supply to Monmouth County. A number of wells in this formation yield more than 0.5 mgd. It is possible to develop a water supply of approximately 5.0 million gallons per day from this source in the County.11

2. Magothy-Raritan Formations

Although the Magothy and Raritan formation are distinct geologic units, they are frequently in direct hydraulic contact and are considered part of the same aquifer system. Northeast of Jamesburg, the Raritan formation has been divided into seven members, three of which are water bearing. Even though it is possible to divide the Raritan formation into seven distinct members, attempts to trace recognized units in the outcrop areas, both along the strike and downdip, have been only moderately successful.[12] Hydrogeologic characteristics of units in Raritan formation have been summarized in Table 4.

3. Magothy Formation

The Magothy formation lies immediately above the Raritan formation and is separated from the Old Bridge Sand member by the Amboy Stoneware Clay. Average porosity of the Magothy formation is 46% and specific yield is approximately 41%. The coefficient of permeability ranges between 60 and 925 with a weighted average of 296. A block of Magothy formation one square mile in area and one foot thick can store 85 million gallons of water.

While the Magothy formation is capable of storing large quantities of water it does not transmit it freely due to its low coefficient of permeability. At the present time no significant supply of water is drawn from this formation although numerous wells for domestic and agricultural uses draw water from this source. Due to its low permeability and transmissivity, successful development of large capacity wells in the Magothy formation would be difficult if not impossible to accomplish.

4. Old Bridge Sand

The Old Bridge Sand member of the Raritan formation is the most productive and intensely developed aquifer in Middlesex County. It outcrops or is exposed beneath permeable Pliestocene deposits in an irregular band that extends from Raritan Bay near South Amboy to and probably beyond Jamesburg. It has an intake area of approximately 25 square miles, a thickness of 80 to 110 feet and dips gently to the southeast at 40 to 45 feet per mile.

The Old Bridge Sand is well sorted and is composed of fairly fine to coarse sand or fine gravel. The average porosity of the Old Bridge Sand is estimated to be 42% and specific yield is 40%. The coefficient of permeability ranges between 1000 and 1500. The Old Bridge Sand is capable of storing and transmitting large quantities of water; for example, a block of Old Bridge Sand one square mile in area and one foot thick would store about 84 million gallons of available water. The sand can transmit approximately 1 mgd for each square mile of aquifer.[13]

5. Farrington Sand

The Farrington Sand outcrops in a contiguous band nearly a mile wide along the southeast edge of Farrington Lake in East Brunswick. It has a total outcrop area of approximately 22.3 square miles, of which 10.9 square miles lie south of the Raritan River and 11.4 square mile lie north. The effective recharge area of the Farrington Sand is 16.9 square miles and has an average thickness of 80 feet, dipping gently to the southeast at the rate of 45 to 55 feet per mile.

The Farrington Sand is a medium to coarse grained sand with an average porosity estimated at 34% and specific yield 32%. The coefficient of permeability ranges between 210 and 3500 with a weighted average between 1,200 and 1,500. The Farrington Sand is also capable of storing and transmitting large quantities of water. A block of the Farrington Sand one square mile in area and 1 foot in thickness would be capable of storing almost 67 million gallons of available water. It can transmit more than 2.5 mgd for each square mile of aquifer.[14]

E. Triassic System

1. Newark Group

The rocks of the Newark Group are the third most important aquifer in the County (behind the Old Bridge Sand and Farrington Sand) because of their areal extent and large amount of water developed from them. The oldest is the Stockton formation consisting of conglomerate and sandstone interbedded with red shale. Next oldest is the Locatong formation consisting of hard shale and argullite. The two rocks are found in a small area near the southwestern border of the County. The Brunswick formation is a red shale interbedded with siltstone and occassional layers of sandstone and covers the entire area north of a line between Carteret and Plainsboro.

These formations are rather impermeable except along numerous cracks which traverse the beds at high angles to the bedding. Some water may flow along the bedding planes but such movements are limited. These rocks dip to the northwest at angles ranging from 5o to 15o

The fact that these rocks are usually fine grained, relatively impermeable and are water bearing by virtue of their cracks and crevices, introduces problems in any attempt to appraise their water bearing capacity. The permeability and specific yield of the Newark Group depends upon the degree of cracking. Since the degree of cracking decreases with the depth, the permeability and specific yield also decreases with the depth. The cracks in the rocks of the Newark Group intersect one another at many angles; the result being that water can move almost in any direction. Figure 3 shows the area of the Brunswick formation covered with permeable material to a thickness of 40 to 45 feet.

The coefficient of transmissibility of the Brunswick Shale is approximately 25,000 (as compared to 96,000 for the Farrington Sand and 108,000 for the Old Bridge Sand) and the storage coefficient is approximately 0.0044.[15] This means that Farrington and Old Bridge Sands can transmit four times as much water as the rocks of Newark Group under a given hydraulic head and through a given width of section. The difference in the capacity of the Newark Group to store water is even more striking. For one square mile area and 300 feet of saturated thickness Newark Group rocks would hold only 275 million gallons of water. By comparison 80 feet of the Farrington Sand would hold 5,360 million gallons of water for the same area. The low storage capacity explains the high rate of run-off and low ground water flows observed in streams draining areas underlain by Newark Group formations where there is no permeable cover material.

TABLE 4

HYDROGEOLOGIC CHARACTERISTICS OF UNITS OF THE RARITAN FORMATION - MIDDLESEX COUNTY

Unit	Lithologic Description	Physical Properties: Average Porosity (percent by volume)	Physical Properties: Permeability[1]	Remarks
Amboy Stoneware Clay	Light-gray to nearly black clay; abundant carbonaceous materials; locally has mottled red appearance; in some places gray to black sandy clay; Lignitic. Thickness to 30 feet.	-	-	An aquiclude[2]
Old Bridge Sand	White to light-yellow, fine to medium grained, occasionally coarse grained, slightly micaceous sand; locally contains thin, irregular clay beds. Thickness 80 to 110 feet. Dips southeast 40 to 45 feet per mile.	40	1000 - 1500	Most productive aquifer in the Raritan Formation and the County. Effective intake area is 33 square miles.
South Amboy Fire Clay	Varicolored light-gray, white or brick-red clay; locally sandy. Thickness to 35 feet.	-	-	An aquiclude
Sayreville Sand	Layers of fine white micaceous sand, fine to coarse grained white sand, with or without clay and arkosic sand beds. Usually thin and lacks continuity. Thickness to 40 feet.	44	30 - 500	Owing to thinness and lack of continuity, this sand member is unimportant as an aquifer. So far as known, no wells in this area draw water entirely from this aquifer.
Woodbridge Clay	Dark-gray clay to sandy clay and clayey sands. The basal part is varicolored white, light-gray, and brick-red compact clay. Thickness 50 to 100 feet.	-	-	An aquiclude
Farrington Sand	Light-gray or light-yellow, fine to medium grained sand grading into coarse arkosic sand sprinkled with small pebbles and gravel in the lower part. This sand is commonly divided by clay layers into two or more parts. Thickness 35 to 135 feet. Dips southeast 55 feet per mile.	34	1200 - 1500	Second in importance as a productive aquifer to the Old Bridge Sand. Total intake area is 17 square miles.
Raritan Fire Clay	Varicolored blue, grown, gray or red clay. Basic component has brick-red color. Thickness to 90 feet.	-	-	An aquiclude

Note: Summarized from "The Groundwater Supplies of Middlesex County, N.J." Henry C. Barksdale, et. al., State Water Policy Commission, Special Report No. 8., 1943.

[1]Coefficient of permeability is the rate of flow of water in gallons per day through a cross sectional area of one square foot under a hydraulic gradient of 100% at the prevailing temperature.

[2]A geologic formation, although porous and capable of absorbing water slowly, will not transmit it fast enough to furnish an appreciable supply for a well or a spring.

F. Groundwater Recharge

1. Natural Recharge

As was previously stated the Old Bridge Sand is the most productive aquifer in Middlesex County and may be the most productive in New Jersey. On the whole the intake area of the Old Bridge Sand is exceptionally well suited for absorbing water from precipitation and streamflow and transmitting it to the water table. It outcrops in an irregular band that extends from the Raritan Bay near South Amboy to and probably beyond Jamesburg. The intake area south of Jamesburg is deeply covered by the Cape May and Pensauken formations which themselves are quite porous and absorb and transmit water readily. Where it has been defined and mapped the intake area is approximately 25 square miles with the effective intake area estimated to be some 33 square miles.[16] Over much of the intake area the land surface is relatively flat, hence water doesn't run off rapidly and instead has an opportunity to percolate into the ground. The sandy nature of the soil reduces the losses by direct evaporation from soil. The vegetation on the soil is not very rank so that evapo-transpiration losses are only moderate. The Farrington Sand is, for much of its area, overlain by permeable soils having excellent drainage which in turn allows for natural recharge.

Henry C. Barksdale estimated that 20 inches of precipitation are available annually for recharging the Old Bridge and Farrington Sands.[17] This is approximately 950,000 gallons/day/square mile. On this basis total natural recharge of the Old Bridge Sand would be 31.35 mgd for an effective intake area of 33 square miles. Natural recharge for the Farrington Sand, for an effective intake area of 17 square miles, would be approximately 16.2 mgd.

It is difficult to estimate natural recharge rate for the undifferentiated Magothy-Raritan formation due at this time to the lack of a detailed investigation. However, while the Magothy formation is capable of storing large quantities of water, it does not generally transmit it freely. This means that recharge rates would be much lower than has been estimated in Middlesex County's Comprehensive Master Plan.[18] Inference from hydrogeological properties leads us to believe that the natural rate of recharge for the Undifferentiated Magothy-Raritan formation is approximately half of the Old Bridge and Farrington Sands or about 0.5 mgd/square mile.

2. Artificial Recharge

As a means of increasing the supply of groundwater, attempts have been made to use man-made groundwater recharge basins. Artificial recharge is defined as augmenting the natural infiltration of precipitation or surface water into underground aquifers by artificially changing natural conditions to allow water to recharge. A variety of methods have been developed, including increasing the extent of water recharge ponds, recharging through pits excavations, wells and shafts and pumping to induce recharge from surface water sources. The choice of a particular method is governed by local topographic, geologic and soils conditions, the quantity of water to be recharged and ultimate water use.

Recharge ponds are presently functioning to varying degrees of success within the Old Bridge Sand outcrop in the Old Bridge-Spotswood area. The Duhernal Water System along with the P.J. Schweitzer and Anheuser Busch Companies pump for wells adjacent to Duheranl Lake which was constructed in 1938 in order to enhance recharge to the Old Bridge Sand . Although the amount of water that is recharged varies, estimates made in 1969 identified that the average rate of recharge for the 173 acre Duhernal Lake is 67,000 gallons/day/acre or approximately 12 mgd is artificially recharged.[19] In recent years, the Duhernal Company has excavated additional recharge ponds adjacent to the lake increasing the recharge area to 221 acres. Total recharge now exceeds 15 mgd.

The Perth Amboy Water Department utilizes Tennent Pond within the Runyon Watershed for artificial recharge purposes. This 63 acre pond recharges the groundwater at a rate of 80,000 to 90,000 gallons/day/acre. A study conducted by Henry C. Barksdale in 1941 indicated that approximately 5 mgd, or virtually the entire flow of Tennent Brook, was being used to recharge the Old Bridge Sand.[20] An additional 100 acre recharge pond on the Deep Run, now in the planning and design stage, is expected to increase the yield of the Perth Amboy wellfield by an additional 7 mgd.[21] The Sayreville Water Department has recently constructed an artificial recharge pond having a total surface area of 66 acres. This pond has been designed to recharge the Old Bridge Sand and is estimated to increase the yield of the Bordentown wellfield by about 4 mgd.

In brief, the safe yield and natural recharge capacity of the Old Bridge Sand has been augmented by some 21.0 mgd, as shown in Table 5 below. Groundwater withdrawal from Old Bridge Sand in the County is within the natural safe yield of 31.0 mgd and total safe yield of 52 mgd.

At the present time artificial recharge is not taking place in Middlesex County to increase the productivity of the Farrington Sand. As noted earlier, groundwater withdrawal from the Farrington Sand is in excess of 18.5 mgd while the safe yield is only 16.2 mgd.22 This strongly suggests that the safe yield of the Farrington Sand is being exceeded evidenced by the decline in the water table and resulting salt water intrusion in the Sayreville area. Due to the location of several wells near the Washington Canal and in the zone of

TABLE 5

Artificial Recharge Operations in Middlesex County - 1974

	Area of Recharge Pond (acres)	Safe Yield
Duhernal Water Company	221	15.0
Perth Amboy Water Dept.	63	5.0
Perth Amboy Water Dept. (Planned)	100 (est.)	7.0 (est.)
Sayreville Water Dept.	66	4.0
Total	450	31.0

REFERENCE NO. 17

United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
New Jersey Agricultural
Experiment Station,
Cook College,
Rutgers,
the State University,
and the
New Jersey Department of
Agriculture

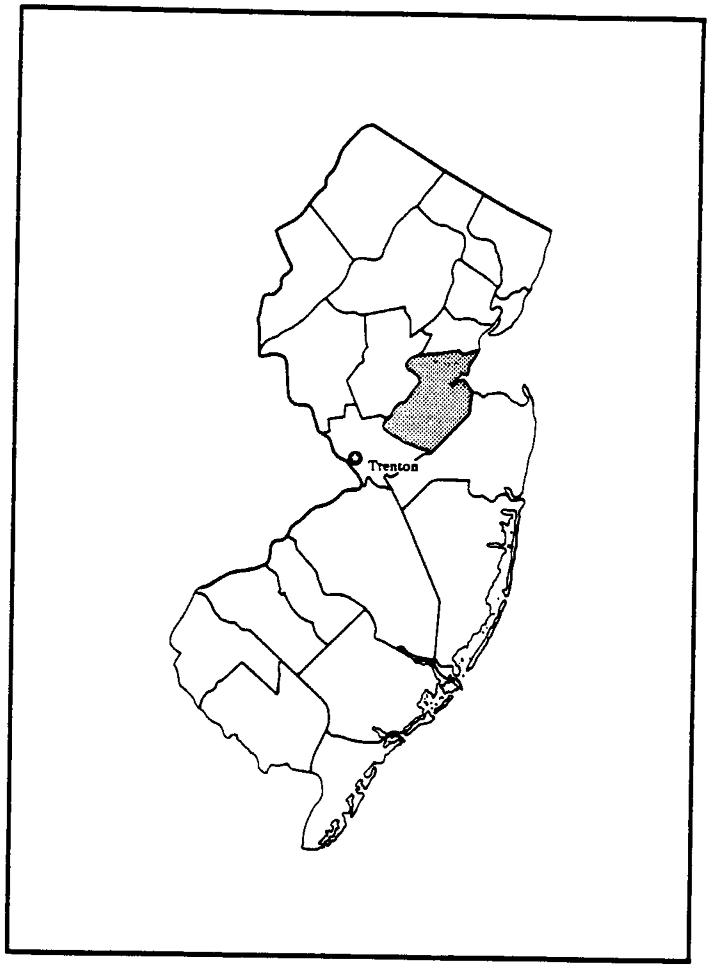
Soil Survey of Middlesex County New Jersey

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1978. Soil names and descriptions were approved in 1979. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1977. This survey was made by the Soil Conservation Service in cooperation with the New Jersey Agricultural Experiment Station, Cook College, Rutgers, the State University, and the New Jersey Department of Agriculture. Others who contributed to the survey were the Middlesex County Board of Chosen Freeholders and the Freehold Soil and Water Conservation District. The survey is part of the technical assistance furnished to the Freehold Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: A field of Japanese yews in Middlesex County.



Location of Middlesex County in New Jersey.

Included with this soil in mapping are small areas of soils similar to this Tinton soil but with more glauconite, a thicker or thinner surface layer, or a surface layer of sandy loam and areas of Fort Mott soils. They make up as much as 25 percent of the unit and generally are managed the same as this Tinton soil. Also included are small areas of Pemberton, Holmdel, and Shrewsbury soils that make up about 15 percent of the unit. They are in depressions or low positions. The other inclusions are throughout the unit.

The permeability of this Tinton soil is moderate or moderately rapid. Available water capacity is moderate. Runoff is slow, and the erosion hazard is moderate. Organic matter content is low, and natural fertility is medium. Tilth is good. In unlimed areas the surface layer is extremely acid and the subsoil and substratum are very strongly acid. The depth to the substratum ranges from 20 to 36 inches but is generally 24 to 30 inches.

This soil is suited to cultivated crops, pasture, or woodland. Vegetables and fruits are the common crops. The main management concerns are the hazard of erosion, low fertility, droughtiness, and the need to increase the organic matter content. Soil blowing is severe if areas are unprotected in winter. Using crop residue maintains or increases organic matter content and reduces soil blowing. The use of lime and fertilizer offsets acidity and low fertility. Conservation tillage and the use of cover crops and grasses and legumes in the cropping system help to reduce runoff and erosion.

This soil is suited to pasture, but the moderate available water capacity is a limitation. Proper seeding, proper stocking, and rotation grazing are the major management practices on this soil.

This soil is suited to trees, and potential productivity is moderately high. Black oak, white oak, and scarlet oak are common in most places, but pines are common where fields have been left idle. Protection from fire is the major management concern.

This soil is generally suitable for most urban uses. The texture of the surface layer and substratum limit the soil as a site for lawns, landscaping, and golf fairways. Some recreation uses are limited by slope.

Capability subclass: IIIs.

UB—Udorthents, bedrock substratum. This unit is nearly level to gently sloping. The areas are irregular in shape and range mainly from 2 to 15 acres. Most areas are smaller than 5 acres. The most extensive areas are principally in Edison, New Brunswick, and North Brunswick Townships.

This unit has been cut and smoothed or otherwise extensively disturbed to a depth of 3 feet or more. The original soil has been removed.

Included with this unit in mapping are small areas of Klinesville, Reaville, Reaville Variant, and Ellington soils on uplands and along the perimeter of the disturbed areas. Small areas of Udorthents, wet substratum, and Urban land are also included.

Some areas of this unit are in native vegetation. Some areas are used for parking lots, landfills, or recreation areas. The variability of the characteristics of this unit makes onsite investigation necessary to determine the suitability of the unit for any use.

Capability subclass: not assigned.

UC—Udorthents, clayey substratum. This unit consists of deep, moderately well drained to somewhat poorly drained soils mostly in regraded clay pits or borrow areas. The surface has been smoothed, and the areas are nearly level.

Most areas of this unit are used for residential, commercial, or industrial development. The variability of the characteristics of the unit makes onsite investigation necessary to determine the suitability of the unit for any use.

Capability subclass: not assigned.

UD—Udorthents, wet substratum-Urban land complex. This unit consists of moderately deep, moderately well drained, loamy soil and urbanized areas. The areas are principally in housing developments or apartment complexes. They dominantly are graded spoil excavated for cellars or foundations or that has been trucked in from nearby areas.

The Udorthents in this unit have a seasonal high water table near the surface. In some areas fill material has been used to cover the water table and thus improve the suitability of the unit as a building site. The thickness of the fill material is 2 to 4 feet, and the average thickness is about 30 inches. The Udorthents are mainly in areas of Fallsington Variant, Reaville Variant, and Parsippany Variant soils.

The variability of the characteristics of this unit makes onsite investigation necessary to determine the suitability of the unit for any use.

Capability subclass: not assigned.

UL—Urban land. This unit consists of areas where more than 80 percent of the surface is covered by industrial plants, shopping and business centers, and other structures. These areas are nearly all in the highly populated northern half of the county. The areas generally range from 2 to 1,000 acres. Most are nearly level to moderately sloping, but a few are strongly sloping and steep. Fill material has been used in places to build up wet soils. Most areas have been excavated or filled with material that is now almost totally paved.

Onsite investigation is needed to determine the potentials and limitations of this unit for any use.

Capability subclass: not assigned.

Wa—Watchung very stony silt loam, 0 to 2 percent slopes. This soil is nearly level and poorly drained. It is

REFERENCE NO. 18

WERBIN
Trube

STATE OF NEW JERSEY
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT

DIVISION OF WATER POLICY AND SUPPLY

SPECIAL REPORT NO. 27

GEOLOGY AND GROUND-WATER RESOURCES OF THE RAHWAY AREA, NEW JERSEY

Prepared in cooperation with
United States Department of the Interior
Geological Survey

1968

GEOLOGY AND GROUND-WATER RESOURCES OF THE RAHWAY AREA, NEW JERSEY

By

HENRY R. ANDERSON

Geologist, U. S. Geological Survey

SPECIAL REPORT NO. 27

1968

Prepared by the U. S. Geological Survey
in cooperation with the State of New Jersey

State of New Jersey

Department of Conservation
and Economic Development

Robert A. Roe, *Commissioner*

Division of Water Policy and Supply
George R. Shanklin, *Director and Chief Engineer*

Water Policy and Supply Council

Mrs. Lillian M. Schwartz, *Chairman*	Highland Park
William G. Bank	Colts Neck
I. Ralph Fox	Rumson
Frederick J. Kaiser	Passaic
Herman A. Klenner	Rahway
Mrs. Hermia Lechner	Clinton
J. Duncan Pitney	Mendham
August C. Schultes, Sr.	Woodbury
David I. Stepacoff	Perth Amboy

Mrs. Martha H. Brenna, *Secretary*

GEOLOGY AND GROUND-WATER RESOURCES OF THE RAHWAY AREA, NEW JERSEY

ABSTRACT

The Rahway area occupies 67 square miles of the Piedmont Plateau and Coastal Plain physiographic provinces in northeastern New Jersey. Lowlands, from less than 10 feet to 80 feet in altitude, constitute most of the area. A terminal moraine of Wisconsin age forms uplands that range in altitude from 100 to 240 feet. The Rahway River, the principal stream, follows a preglacial drift-filled channel through the city of Rahway, and flows into the Arthur Kill.

The Brunswick Shale of Triassic age which underlies the report area is a massive, fractured shale containing sandstone beds. It is more than 6,000 feet thick. The shale strikes N. 50° E. and dips about 9° to 12° NW. The Raritan Formation of Cretaceous age overlies the Brunswick unconformably in the southeast corner of the area. The Raritan Formation is a series of clays and sands of about 100 feet in thickness in the outcrop area. It strikes about N. 45° E. and dips less than 1° SE.

well
Data
it

Wisconsin glacial drift, ranging in thickness from several feet on hilltops to 100 feet in the terminal moraine, blankets the Brunswick Shale and Raritan Formation.

About 6 mgd (million gallons of water per day) is pumped from the Brunswick Shale, which yields water from fracture openings and from pore spaces in the interbedded sandstone. As depth increases, the fractures become smaller and fewer in number and hence yield less water. Recharge to the Brunswick occurs through the hydraulically continuous overlying drift. Interference between wells in the Brunswick is greatest where wells are aligned along the strike of the formation and least where wells are aligned perpendicular to the strike. Both water-table and artesian conditions exist in the Brunswick Shale. Artesian conditions occur generally at depths greater than 100 feet; water-table conditions occur at shallower depths. The average yield of 150 industrial, public-supply, and domestic wells is 75 gpm (gallons per minute). The average specific capacity is 2.2 gpm per foot of drawdown and the average well depth is 218 feet. All industrial and public-supply wells in the Brunswick Shale having a specific capacity of less than one are in the southeastern half of the area.

well
DATA

Ground water from the Brunswick Shale is locally high in sulfate, dissolved solids, and hardness. This is owing to solution of gypsum and calcite in the formation. Concentrations of these constituents increase with depth.

Brackish water is contained in the Brunswick Shale along the tidal reach of the Rahway River and northward along the Arthur Kill. South of the Rahway inlet, the Raritan fire-clay, locally the basal member of the Raritan Formation, overlies the Brunswick Shale and retards sea-water inflow from the Arthur Kill.

About 1 mgd is pumped from the Farrington Sand Member of the Raritan Formation in the report area. Twelve industrial wells have an average yield of 96 gpm, an average specific capacity of 9.5 gpm per foot of drawdown, and an average depth of 60 feet. The Farrington Sand Member is hydraulically separated from the Brunswick Shale by the basal Raritan fire-clay. Salt water is encountered in wells in the outcrop area adjacent to the Arthur Kill.

A stratified-drift deposit having an average thickness of 30 feet underlies the city of Rahway. More than a million gallons per day is pumped from four wells tapping both the drift and the underlying Brunswick Shale. The average yield of the wells is 370 gpm, and the average specific capacity is 15.3 gpm per foot.

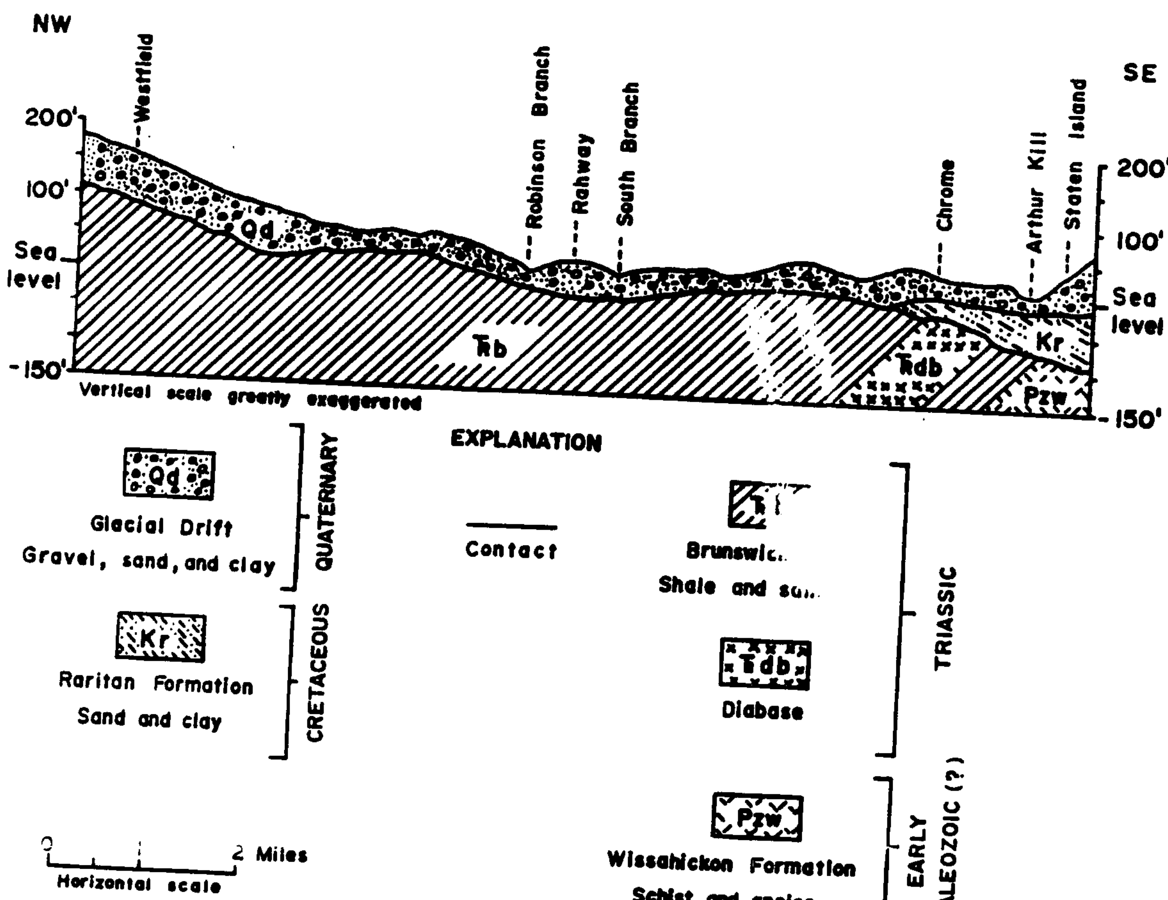


Figure 3.—Generalized geologic cross section through the Rahway area.

TABLE 1.—STRATIGRAPHIC UNITS IN THE RAHWAY AREA AND THEIR GEOLOGIC AND HYDROLOGIC CHARACTERISTICS

	Unit	Geologic characteristics	Hydrologic characteristics
	Alluvium	Muds and sands deposited in river channels and estuaries; 0 to 50 feet thick.	Muds are relatively impermeable and serve to retard seepage between rivers and the ground-water reservoir, and most important, to retard flow of saline water through river beds.
	Eolian deposits	Sand, white, forming dunes along the Arthur Kill. Less than 10 feet thick.	Deposits lie above water table but transmit water readily to underlying sediments because of high infiltration capacity and permeability.
	Till	Clay, sand, and gravel, reddish-brown, unstratified, and unsorted. Forms most of the surficial ground and terminal moraine deposits; 0-100 feet thick. Deposited directly by glacier.	Not an important source of ground water because of low permeability and small thickness which lies below the water table. Yields water to dug domestic wells.
	Stratified drift	Sand and gravel, sorted and stratified, occurring as fill in bedrock channels and interbedded with till in the terminal moraine; 0-60 feet thick. Deposited by water.	Important as an aquifer only in the city of Rahway where wells tap both the Brunswick Shale and stratified drift and induce recharge from the Rahway River. Average well yield 370 gpm. Quality of water is good.
	Pensauken Formation	Sand and gravel; chiefly quartz. Some pebbles and cobbles of shale, sandstone, quartz and crystalline rocks.	Yields no water to wells.
	Unconformity		
Raritan Formation	Sayreville Sand Member	Sand, fine to coarse, white, micaceous; contains clay and arkosic sand beds. Locally crossbedded. 0-40 feet thick.	Not an important source of water north of the Raritan River as much of it lies above the water table. At Sayreville, N. J. the specific yield ranges from 32 to 39 percent and the coefficient of permeability ranges from 30 to 500 gpd per sq. ft.
Raritan Formation	Woodbridge clay	Upperbeds – clay, black lignitic; contains siderite, pyrite, and interbedded sand lenses. Lowerbeds – clay, varicolored and locally sandy. Total thickness 0-60 feet.	Confining bed.
Raritan Formation	Farrington Sand Member	Sand, fine to very coarse, light colored; contains interbedded arkosic sand and clay. 0-80 feet thick.	Yields moderate amounts of good quality water. Average transmissibility 10,000 gpd per ft. Average well yield is 96 gpm. Salt water encountered in wells adjacent to the coast. Permeabilities at Parlin, N. J. range from 210 to 3,500 gpd per sq. ft. Specific yield ranges from 25 to 36 percent.
Raritan Formation	Raritan fire clay	Clay, varicolored blue, brown, gray, or red. Reddish-brown at basal contact with Brunswick Shale. 2-35 feet thick.	Confining bed.
	Unconformity		
Newark Group	Igneous intrusive	Buried diabase sill in southeastern part of report area that forms Palisades where it crops out on Staten Island.	Dense and relatively impermeable. No wells tap the sill.
Newark Group	Brunswick Shale	Shale, reddish-brown, fractured; contains interbedded sandstone. Underlies glacial drift and Raritan Formation in the Rahway area. Altered to hornfels adjacent to diabase. 6,000 to 9,000 feet thick. Strikes N. 50° E. Dips 9-12° NW.	Most intensely developed aquifer in area. Yields small to moderate quantities of water from primary openings in sandstone and from secondary openings which decrease with depth in shale and sandstone. Water locally high in sulfate, total dissolved solids, and hardness. Both water table and artesian conditions exist. Interference is greatest between wells aligned along strike of formation. Average transmissibility 16,000 gpd per ft. Yield range 2 to 660 gpm. Average yield 75 gpm. [illegible]

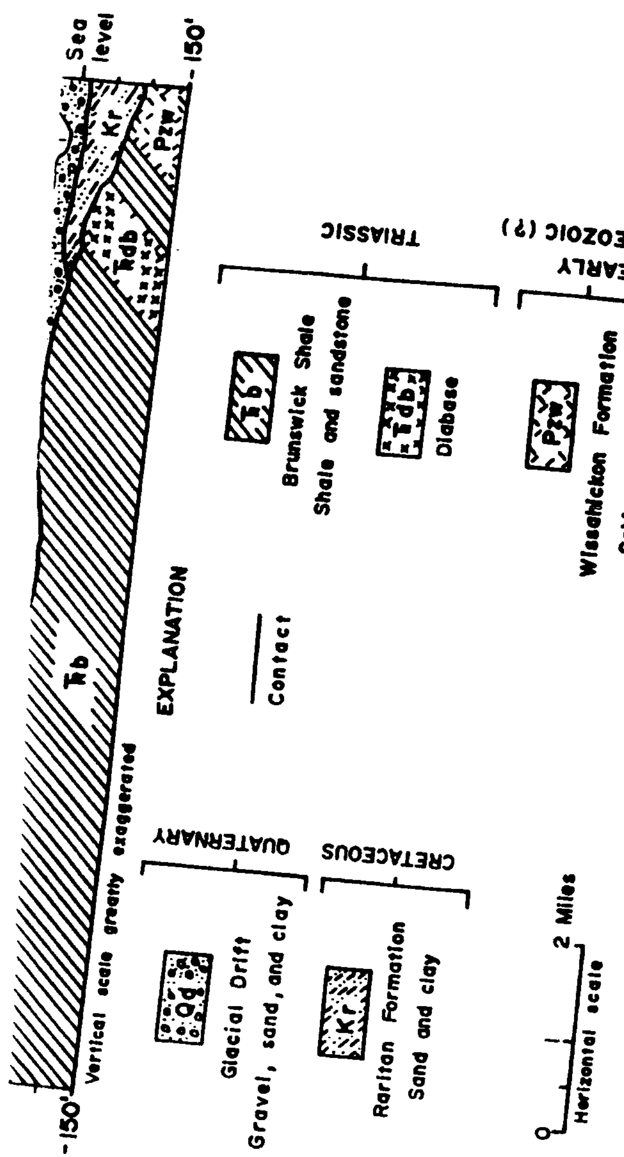


Figure 3.—Generalized geologic cross section through the Rahway area.

TABLE 1.—STRATIGRAPHIC UNITS IN THE RAHWAY AREA AND THEIR GEO

Era	Period	Epoch		Unit	Geologic characteristics
	Quaternary	Recent		Alluvium	Muds and sands deposited in river channels and estua feet thick.
				Eolian deposits	Sand, white, forming dunes along the Arthur Kill. 10 feet thick.
		Pleistocene		Till	Clay, sand, and gravel, reddish-brown, unstratified, sorted. Forms most of the surficial ground and termi aine deposits; 0-100 feet thick. Deposited directly b
				Stratified drift	Sand and gravel, sorted and stratified, occurring as f rock channels and interbedded with till in the termin 0-50 feet thick. Deposited by water.
				Pensauken Formation	Sand and gravel; chiefly quartz. Some pebbles and shale, sandstone, quartz and crystalline rocks.
MESOZOIC	Cretaceous	Late Cretaceous	Raritan Formation	Unconformity Sayreville Sand Member	Sand, fine to coarse, white, micaceous; contains cla arkosic sand beds. Locally crossbedded. 0-40 feet t
				Woodbridge clay	Upperbeds – clay, black lignitic; contains siderite, and interbedded sand lenses. Lowerbeds – clay, vari and locally sandy. Total thickness 0-60 feet.
				Farrington Sand Member	Sand, fine to very coarse, light colored; contains int arkosic sand and clay. 0-80 feet thick.
				Raritan fire clay	Clay, varicolored blue, brown, gray, or red. Reddis at basal contact with Brunswick Shale. 2-35 feet thi
	Triassic	Late Triassic	Newark Group	Unconformity Igneous intrusive	Buried diabase sill in southeastern part of report area Palisades where it crops out on Staten Island.
				Brunswick Shale	Shale, reddish-brown, fractured; contains interbedded Underlies glacial drift and Raritan Formation in the R area. Altered to hornfels adjacent to diabase. 6,000 feet thick. Strikes N. 50° E. Dips 9-12° NW.

HYDROLOGY

Water falls to the earth's surface as precipitation. Part is intercepted by vegetation, pavements, and buildings before reaching the ground and is evaporated. Part infiltrates the ground to become soil moisture, capillary water, and ground water. The remainder of the water runs off the land surface to the streams. Evaporation and transpiration take place during these processes, returning to the atmosphere moisture which eventually becomes precipitation again.

OCCURRENCE OF GROUND WATER

Water that percolates to the zone of saturation is ground water. The water table is the upper surface of the zone of saturation and separates that zone from the overlying zone of aeration. The moisture content of the zone of aeration ranges from saturation to a dry state.

Ground water in the Rahway area is stored in and transmitted through pore spaces of unconsolidated sediments such as glacial drift and the Raritan Formation. Joints and other fractures store and transmit the water in the consolidated rocks of Triassic age.

Water-table, or unconfined, ground-water conditions exist when the top of the zone of saturation is at atmospheric pressure. Such conditions occur in the stratified drift in Rahway, in the outcrop area of the Raritan Formation, and at shallow depths in the Brunswick Shale.

Artesian, or confined, conditions occur where ground water is under hydrostatic pressure greater than atmospheric pressure. Pumping from a confined aquifer quickly lowers the artesian pressure and water levels drop rapidly in nearby wells penetrating the same aquifer. Artesian conditions are found in the deeper parts of the Brunswick Shale and in the Raritan Formation beneath the Woodbridge clay. Several artesian wells in the Brunswick Shale flow; these are aligned northeast-southwest along the South Branch of the Rahway River. These wells probably tap a common fracture or fault system which trends northeast-southwest through the area.

MOVEMENT OF GROUND WATER

Ground water moves from points of high ground-water head to points of lower ground-water head. The generalized water-level contour map of the area (fig. 5) shows the altitudes of ground-water levels at the time of well completion. As water-level highs generally coincide with topographic highs, ground water flows generally in the same direction as overland surface flow. Ground-water movement is toward the Rahway River and its branches and through the gravel-filled valley extending from Rahway to the Arthur Kill. Hydraulic gradients range from less than

10 feet per mile, in the Rahway lowland, to more than 80 feet per mile in the southwest half of the area, where the greatest topographic relief occurs.

RECHARGE, DISCHARGE, AND WATER-LEVEL FLUCTUATIONS

Recharge to the zone of saturation occurs primarily from precipitation
that infiltrates the soil and percolates to the water table. The amount
of precipitation that reaches the water table varies throughout the year
and depends on the vegetative cover, soil moisture and permeability,
temperature, and the type, duration, and intensity of precipitation.

Ground-water recharge may occur also along streams and lake banks
by influent seepage from surface-water bodies after heavy rainfalls. The
river or lake level rises faster from direct precipitation and surface run-
off than does the water table. The slope of the water table is temporarily
reversed and surface water seeps into the aquifer. This water is bank
storage and is returned to the stream or lake once the surface-water level
falls below the water table.

When the amount of water reaching the zone of saturation exceeds
the amount being withdrawn by natural and artificial discharge, the
water table rises. As shown in figure 6a, the rise in water levels in-
dicates recharge exceeds discharge from the end of October to the middle
of April, during the time when evapotranspiration is lowest.

Discharge of ground water occurs both naturally and artifically. Dis-
charge by natural means includes effluent seepage to perennial streams.
lakes, and tidal areas; transpiration by plants whose roots extend to
the water table or the overlying capillary fringe; and evaporation where
the water table is near the land surface. Ground water is discharged
artificially by the pumping or flowing of wells. Discharge from flowing
wells in the Rahway area is slight. The amount removed by pumping.
however, is significant and is about 8 mgd, of which about 5 or 6 mgd
are from the Rahway River watershed area.

The decline in water level in the hydrograph of observation well
26.21.5.4.6 (fig. 6a) shows that discharge exceeds recharge to the water
table during the growing season, April through October. The decline
in ground-water levels is accompanied by a decrease in stream runoff.
April through October (fig. 6b). Stream runoff declines partly because
as the water-table gradient decreases. ground water discharge to the
streams decreases. Overland flow to streams also decreases during the
spring-summer period because most precipitation either evaporates or
infiltrates the soil, where it is transpired by plants. It is apparent from
figure 6c that evapotranspiration is at its peak and exceeds precipitation

GEOLOGIC FORMATIONS AND THEIR HYDROLOGIC CHARACTERISTICS

TRIASSIC SYSTEM

Brunswick Shale

Geology

The Brunswick Shale is the youngest formation of the Newark Group, which consists of the Stockton Formation, Lockatong Formation, and the Brunswick Shale. The Brunswick Shale has the most extensive outcrop area and is composed of 6,000-8,000 feet of fractured reddish-brown shale and locally interbedded sandstone. Sandstone beds increase in abundance northeastward, becoming predominant in the northernmost part of the outcrop area in New Jersey. Along the northwest edge of the outcrop, the Brunswick grades into a conglomerate. According to Boch (1959), the red color originates from reworked hematite, which comprises 5 to 10 percent of the formation. Although red predominates, some purple, green, yellow, and black layers occur in the lower 2,000 feet of the Brunswick.

well
DATA
IT

In the Rahway area, the characteristic reddish-brown shale constitutes most of the formation, although interbedded sandstone and green and black shale also occur. Glacial drift blankets the Brunswick in most of the area, but exposures can be seen at Iselin and Menlo Park. Shale intruded by the Palisade Diabase is altered into a spotted hard slate that is dark green to gray in color.

The Brunswick Shale strikes N. 50° E. and dips 9° to 12° NW in the report area. The predominant system of fractures strikes about N. 45° E. and is vertical. A second, less prominent, system strikes N. 75° W. and is nearly vertical.

The presence of ripple marks, mudcracks, raindrop impressions, reptile footprints, and plant, reptile, and fish fossils indicates that the Brunswick Shale was deposited in a shallow-water continental environment.

well
DATA

The source of the sediments is generally considered to be Precambrian or early Paleozoic(?) metamorphic and igneous rocks to the southeast. The occurrence of detrital micas and feldspars support this.

The Brunswick Shale conformably overlies and is interfingered with the Lockatong Formation. In northern New Jersey, where the Lockatong is absent, the Brunswick overlies the Stockton Formation.

On exposure to weathering, the shale disintegrates readily into blocky and nodular-shaped fragments and chips that flake off along the bedding planes (fig. 8). The shale ultimately disintegrates into a hard clay.

Figure 8.—Photograph of exposure of the Brunswick Shale on the north shore of the Raritan River at Perth Amboy, showing the secondary fractures and nodular-shaped weathering fragments.

HYDROLOGIC CHARACTERISTICS

More ground water is obtained from the Brunswick Shale than from any other formation in the Rahway area. Approximately 90 percent of the wells in the report area tap the Brunswick, and they yield a total of more than 6 mgd. The remaining 10 percent of the wells obtain water from the Raritan Formation or glacial drift.

Water is stored and transmitted primarily in the secondary fracture openings that formed after the deposition of the sediments. The primary opening or pores between the particles in the shale are too small to transmit water readily. Locally, the fracture openings are widened by percolating ground water that dissolves material from the walls of the fractures. The size of the fracture openings generally decreases, with depth, because the weight of overlying rock increases.

Cavities formed by the solution of calcite and gypsum may be common locally, but are not considered an important source of ground water.

The Brunswick Shale and the overlying glacial drift are hydraulically continuous in most areas. Infiltrated precipitation percolates directly through the till or stratified drift and into the fracture openings of the shale.

Ground water occurs under both water-table and artesian conditions in the Brunswick Shale. If the fractures have nearly vertical dips and

are hydraulically continuous with permeable drift, ground water is unconfined and water-table conditions prevail. This condition is found commonly in wells less than 100 feet deep. A decline in the water level in a water-table well indicates that part of the aquifer has been dewatered.

Where the fracture openings do not extend upward to permeable drift or where permeable sandstone layers are interbedded with impermeable shale, ground water is confined under artesian pressure. The lowering of the water level in an artesian well reflects changes in pressure within the aquifer and does not indicate dewatering of the aquifer. Wells penetrating the Brunswick Shale are uncased below the glacial drift, so both water-table and confined zones may be intercepted in a single well.

The observation well at Hatfield Wire and Cable Co. (26.31.2.3.5) responds as an artesian well. The water level in this well lies below the regional water table and drops about 6.4 feet in 2 hours when an air-conditioning well (26.31.2.5.3.) 3.500 feet to the southwest begins pumping The two wells are aligned parallel to strike and probably penetrate the same system of bedding-plane fractures or sandstone beds. Other wells nearly at right angles to a line connecting these two and only a few hundred feet distant from the pumping well show a smaller drop in water levels. This suggests that water levels in wells aligned perpendicular to the strike of the Brunswick Shale interfere less with one another than wells aligned parallel to the strike.

The Brunswick is not a homogenous isotropic aquifer as the permeability varies greatly from one area to another as well as with direction at any one locality. In most cases, the drawdown rate in an observation well is greatest when the observation well and the pumped well are aligned parallel to the strike of the formation. Data obtained by Herpers and Barksdale (1951) from pumping tests in Newark, New Jersey, demonstrated similar conditions.

Wells that tap the Brunswick Shale range in yield from 2 to 660 gpm, and the average is 75 gpm. Yields of wells larger than 6 inches in diameter (non-domestic use) average 140 gpm.

Specific capacities of all Brunswick Shale wells range from 0.1 to 25 gpm per foot of drawdown and average 2.2. For wells larger than 6 inches in diameter, the average specific capacity is 3.6 gpm per foot of drawdown. Wells 26.21.8.2.9A and 26.31.1.3.1B (table 5) in the northwestern half of the area, penetrate sandstone beds and have specific capacities greater than 7. All industrial and public-supply wells with a specific capacity of less than one occur southeast of a diagonal line extending from Metuchen to Elizabeth. Hence, specific capacities are, on the average, greater in the northwestern than in the southeastern half of the

Depths of wells in the Brunswick Shale range from 60 to 1,566 feet and average 218 feet. For wells larger than 6 inches in diameter, the average depth is 340 feet.

Quality of water

The quality of water in the Brunswick Shale varies greatly with locality and depth. The ground water in some areas is highly mineralized, averaging more than 500 ppm of dissolved solids. Locally, it contains excessive amounts of sulfate.

Mineralization of ground water generally increases with depth. This relation is illustrated by the Merck well (26.31.2.6.7B), which is 1,108 feet deep. Water samples from the Merck well contained 1,795 ppm sulfate and 280 ppm calcium. Ground water from the Squire Island (26.31.2.6.4) 300-foot well and the Milton Lake (26.31.2.7.4) 301-foot well, contain 1,358 and 883 ppm sulfate, 279 and 198 ppm calcium, and 2,660 and 1,445 ppm dissolved solids, respectively. The Security Steel well (26.31.5.9.4), which is 614 feet deep, yields water with only 162 ppm sulfate, 67 ppm calcium, and 528 ppm dissolved solids. The unusual concentrations of sulfate and calcium may be from solution of calcite and gypsum layers within the formation.

The tidal reaches of the Rahway River and Arthur Kill also have high concentrations on these constituents but low chloride concentrations in the well samples indicate that salt-water intrusion is not the cause of the high mineralization.

The average temperature of water in the Brunswick Shale is about 55°F. Temperatures are generally lowest near the water table and increase with depth. The Standard Oil Company well (26.32.1.1.8) drilled in May 1920 to a depth of 1,556 feet encountered water which increased in temperature from 70° to 90°F below 800 feet in depth.

Salt-water contamination

Because the Brunswick Shale has at least a partial hydraulic connection with the Arthur Kill, whose water has a chloride concentration greater than 15,000 ppm, an interface is developed between the salt water of the estuary and the less dense, fresh ground water in the aquifer. According to the Ghyben-Herzberg principle (Drabbe and Ghyben, 1889 and Herzberg, 1901) the hydrostatic pressure at the base of a 41-foot column of fresh water of density 1.000 equals the hydrostatic pressure at the base of a 40-foot column of salt water with an average density of 1.025. Applying this relation to coastal aquifers such as the Brunswick Shale, salt water theoretically occurs 40 feet below sea level where the ground-water head in a well is one foot above sea level. Consequently, if ground-water levels are allowed to decline to below sea

Consequently if ground-water levels are allowed to decline below sea level, the fresh ground water will be replaced eventually by sea water.

Brackish water is contained in the Brunswick Shale along the tidal reach of the Rahway River and northward along the Arthur Kill. South of the Rahway inlet, the Raritan fire-clay overlies the Brunswick and retards sea-water inflow.

CRETACEOUS SYSTEM

Raritan Formation

Geology

The Raritan Formation of Late Cretaceous age covers about 9 square miles in the southeast part of the Rahway area. Most of the formation is overlain by glacial drift, but is exposed at the surface where commercial clay and sand pits have been developed. The Raritan Formation was named by T. A. Conrad in 1869 who described its lower clay members exposed along the Raritan River.

The Raritan Formation consists of light-colored alternating sands, clays, and gravels of continental origin, interbedded with tongues of marine sediments. The upper and lower parts of the formation are predominantly sand, the lower sands being coarser and more arkosic than the upper. The middle of the formation contains white clays which weather to red, and also dark lignitic clays that grade laterally and vertically into white or red non-carbonaceous clays. The sands are characteristically well sorted, medium to coarse grained, and micaceous; they are locally cross-bedded. The clays are massive, plastic, and contain pyrite, lignite, and carbonized material which imparts a bluish or gray color.

The thickness of the Raritan changes locally because the materials were deposited on an irregular surface of Triassic, Precambrian, and early Paleozoic(?) rocks. In outcrop, the thickness ranges from 150 to 300 feet. Downdip to the southeast, it thickens to more than 1,000 feet.

A variety of fossil fauna and flora which have been found include brackish water and marine pelecypods, dicotyledons related to modern flora, and dinosaur footprints. The Raritan is considered to be Late Cretaceous in age.

Kümmel (Ries, Kümmel, and Knapp, 1904) divided the Raritan in Middlesex County into seven members according to lithology. The members were later renamed by Barksdale and others (1943), from oldest to youngest, (1) Raritan fire clay, (2) Farrington Sand Member, (3) Woodbridge clay, (4) Sayreville Sand Member, (5) South Amboy fire clay, (6) Old Bridge Sand Member, (7) Amboy stoneware clay. Because of their lenticular nature, the members are not traceable outside the county. The four lower units crop out in the report area and will be discussed as Kümmel described them.

The Raritan fire clay is a white, light blue, or spotted red clay that grades downward into a reddish-brown color toward the underlying Brunswick Shale. It ranges from 2 to 35 feet in thickness and is found mostly in depressions in the Brunswick Shale where it grades almost imperceptibly into the Brunswick. The top of the clay is undulatory and is overlain by the Farrington Sand Member of the Raritan Formation or by glacial drift.

The Farrington Sand Member is mostly an angular quartz sand containing, locally, thin beds of gravel and seams of clay. The upper part is a medium- to fine-grained sand, and the lower 10 to 20 feet are light-gray to light-yellow, coarse, arkosic sand containing rounded quartz and black chert pebbles 6 to 50 mm in diameter. The maximum thickness of the sand in Middlesex County is 80 feet, but it is thinner in the Rahway area.

The Woodbridge clay overlies the Farrington Sand Member. The Woodbridge ranges in thickness from 50 to 80 feet but it is eroded to 20 feet in some exposed areas. It ranges from a fire clay at the base to a black laminated lignitic clay at the top. The thickness of the upper bed ranges from 30 to 60 feet where it is not eroded. The basal fire clay is light blue to gray or mottled red in color and has an average thickness of about 20 feet. The average quartz sand content of the fire clay is about 5 percent; however, the bottom and top parts contain as much as 50 percent sand. The base of the fire clay is undulatory. Its upper surface is irregular where glaciers have scoured away some of the top material.

The Sayreville Sand Member is an irregular channel-fill deposit composed of a feldspar sand and a kaolin sand. The sands are lenticular and do not occupy definite stratigraphic horizons. The feldspar sand contains subrounded quartz grains, kaolinized feldspar, and clay pellets. The kaolin sand is a micaceous, very fine-grained white quartz sand containing white clay. At Sayreville, 8 miles southwest of Woodbridge, the Sayreville Sand Member is predominantly medium to coarse grained.

Hydrologic Characteristics

The Raritan Formation, unlike the Brunswick Shale, yields water primarily from the intergranular pore spaces. The Raritan lies almost wholly outside the Rahway River watershed. Its aquifers are separated hydraulically from the underlying Triassic shale by the basal Raritan fire clay. In the outcrop areas of the sands of the Raritan Formation, ground water is unconfined. Downdip where the sands underlie clay beds, confined or artesian conditions exist.

The Sayreville Sand Member is discontinuous laterally and much of it lies above the water table; therefore, it is not an important source of water north of the Raritan River. Laboratory analyses of samples from exposures in Sayreville showed specific yields ranging from 32 to 39 percent and coefficients of permeability ranging from 30 to 500 gpd per square foot. The two clay members, the Raritan fire clay and the Woodbridge clay, do not yield water and act as aquicludes for the Farrington Sand Member.

Barksdale and others (1943) estimate that about 1.9 mgd was pumped from the Farrington north of the Raritan River in the 1930's and early 1940's. However, salt water, drawn in by the pumping of wells along the Arthur Kill, forced many industries to obtain water from inland public-water supply companies so that at present, only about 1 mgd is pumped from the Farrington Sand for a few large industries in the Rahway area.

Most wells tapping the Raritan have water levels that are less than 10 feet above sea level. Hence, north of the Raritan River, the aquifer has little potential yield because lowering water levels to sea level will eventually result in replacement of fresh ground water by salt water.

Results of 15 pumping tests conducted at the California Oil Company (26.31.8.8.9) in October 1950 showed a range in transmissibility from 7,000 to 14,000 gpd per foot and an average of 10,000 gpd per foot. The coefficient of storage ranged from 0.003 to 0.00001, indicating artesian conditions.

The coefficient of transmissibility of the Farrington at Parlin, which is south of the report area, is several times greater than that at the California Co. site because the aquifer is thicker there. Transmissibilities computed from pumping tests in the Parlin area are as high as 100,000 gpd per foot; the average is 50,000 gpd per foot—five times the value of the California Company tests. At Parlin, the aquifer is 80 feet thick, which is about twice as thick as it is at the California Co. site. Laboratory determinations of the coefficient of permeability of the Farrington Sand Member at Parlin range from 210 to 3,500 gpd per square foot and average 1,650 gpd per square foot. Specific yields range from 25 to 36 percent and average 31 percent.

Yields of 12 industrial wells range from 6 to 300 gpm and average 96 gpm. Specific capacities range from 1.9 to 39 and average 9.5 gpm per foot of drawdown. Wells tapping the Raritan Formation in the report area range in depth from 40 to about 120 feet, the greater depths occurring downdip. The average depth is about 60 feet.

Quality of water

The quality of the water from the Raritan Formation is very good for most uses. It rarely contains excessive amounts of sulfate or dissolved solids, and it is not as hard as water from the Brunswick Shale. Total dissolved solids range from 154 to 384 ppm. The temperature of the water averages about 54°F.

Salt-water contamination

Salt-water encroachment has occurred in areas where there are heavily pumped wells adjacent to the Arthur Kill. However, 1 mile or more inland there is generally sufficient fresh-water head to allow, indefinitely, present rates of withdrawal with safety. If encroachment were to occur inland, salt water probably would flow laterally into the Farrington outcrop from Woodbridge Creek and the Arthur Kill near Sewaren. Encroachment in an updip direction from the Raritan River is possible also, as discussed by Barksdale and others (1943).

QUATERNARY SYSTEM

Pleistocene Series

Pensauken Formation

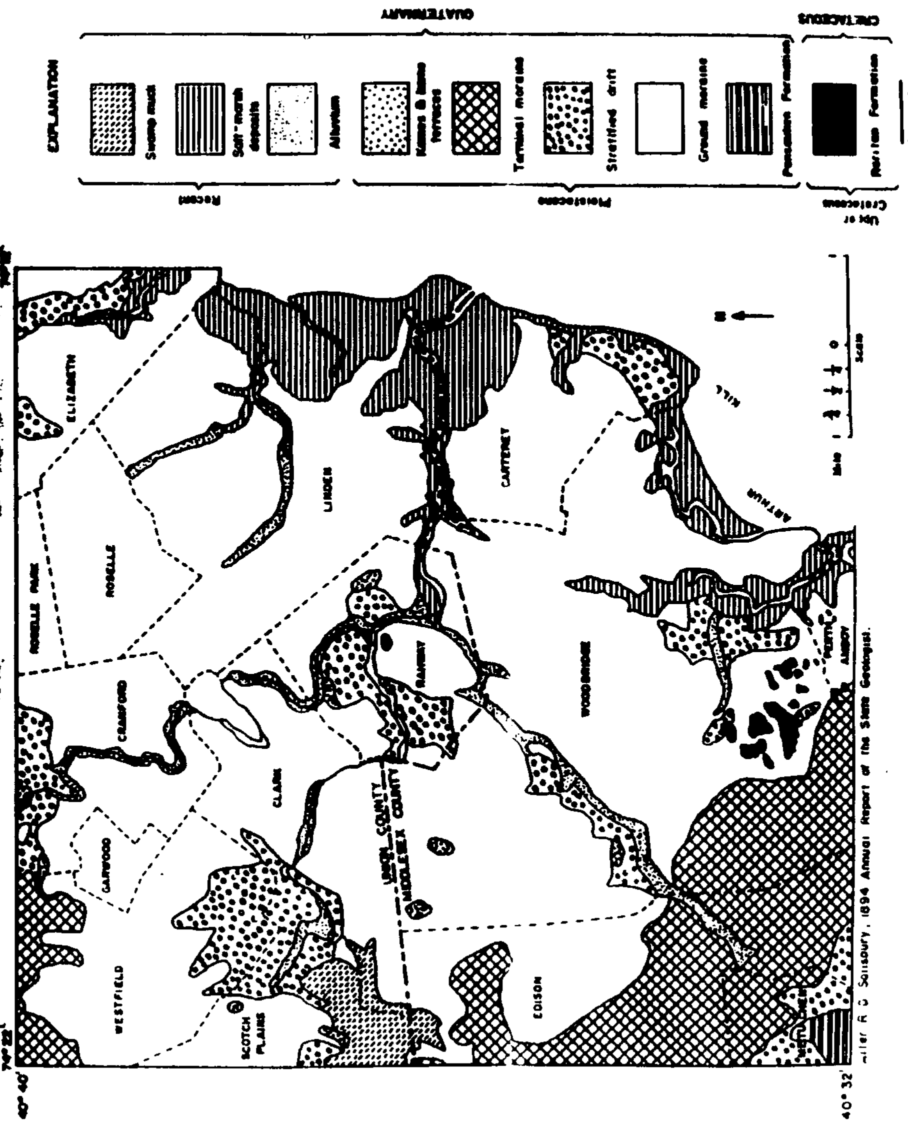
The oldest deposit of Pleistocene age in the Rahway area is the Pensauken Formation, which forms the high terrace in the southwestern corner of the area. The Formation consists chiefly of quartz sand and gravel. In addition, pebbles and cobbles of shale, sandstone, quartzite, and crystalline rocks are present. So far as known, no wells obtain water from the Pensauken Formation.

Glacial Drift

Geology

Glacial drift mantles the Brunswick Shale and the Raritan Formation (fig. 9) and forms the land surface of the report area. The drift has an average thickness of about 25 feet, but ranges in thickness from a few feet on bedrock hilltops to 100 or more feet in the terminal moraine. Till, which is poorly sorted unstratified drift, occurs as ground or terminal moraine. It was deposited directly by the ice sheet. Till in the report area is characteristically a reddish-brown clay, derived from the Brunswick Shale, and contains pebbles and boulders of resistant gneiss, quartzite, sandstone, quartz, and diabase derived from rocks north of the terminal moraine. Pebbles of the Brunswick Shale are rare because the material disintegrates readily into small particles.

Stratified drift, which was deposited by glacial melt waters, occurs in lo[redacted] a[redacted]orth[redacted] sou[redacted] th[redacted]min[redacted]rain[redacted] we[redacted]



After R. D. Salisbury, 1894 Annual Report of the State Geologist.

Figure 9.—Surficial geologic map.

interbedded with till in the terminal moraine. The sand and pebbles are similar in mineralogy to those in the till, but the stratified drift contains very little clay.

The most important water-bearing drift deposit is that underlying the city of Rahway. It is predominantly a sand, containing interbedded gravels and till, that fills a preglacial stream valley. The stratified drift has a maximum thickness of 50 feet near the confluence of the Rahway River and Robinson Branch; the average thickness is about 30 feet. The lithology and general character of this deposit are variable (fig. 10).

In well drained areas, the glacial drift is leached and oxidized to a depth of 2 to 3 feet. The upper 6 to 10 inches is a dark-red-brown soil.

Hydrologic characteristics

The stratified drift filling the buried valley in Rahway is the only important aquifer of Pleistocene age in the report area. The Rahway Water Department withdraws more than a million gallons of water a day from four wells that are screened 15 feet in the stratified drift and penetrate 25 to 50 feet into the underlying Brunswick Shale. The water is obtained from both stratified drift and the Brunswick Shale. The wells are near the Rahway River, and much of their yield is water induced into the aquifers from the river. The average yield of the four 10-inch diamter wells is 370 gpm. The average specific capacity is 15.3 gpm per foot. A 6-inch observation well in the well field which taps only the drift has a yield of 125 gpm, and a specific capacity of 6.2 gpm per foot.

Aquifer-test data are lacking for the stratified drift at Rahway, but some indication of its water-bearing capacity may be inferred from grain-size distribution of eight samples taken from two test wells drilled in Rahway. Laboratory coefficients of permeability for water-yielding materials having size distributions similar to the drift at Rahway are in the order of 1,000 gpd per sq ft or greater (Wenzel, 1942, p. 13). Accordingly, if the drift at Rahway has a saturated thickness of 30 feet, its coefficient of transmissibility is probably about 30,000 gpd per ft or greater. The coefficient of storage is probably between 0.1 to 0.2.

Till is not an important source of ground water in the report area because it has a low permeability, and much of it lies above the zone of saturation. In river valleys, 30 to 40 feet of till may lie below the water table. However, on bedrock hilltops capped with till the water table may be in the underlying Brunswick Shale.

An important function of glacial drift is to absorb, store, and transmit water to the underlying fractured shale wherever they are hydraulically connected. The transmissibility of the stratified drift in Rahway is ap-

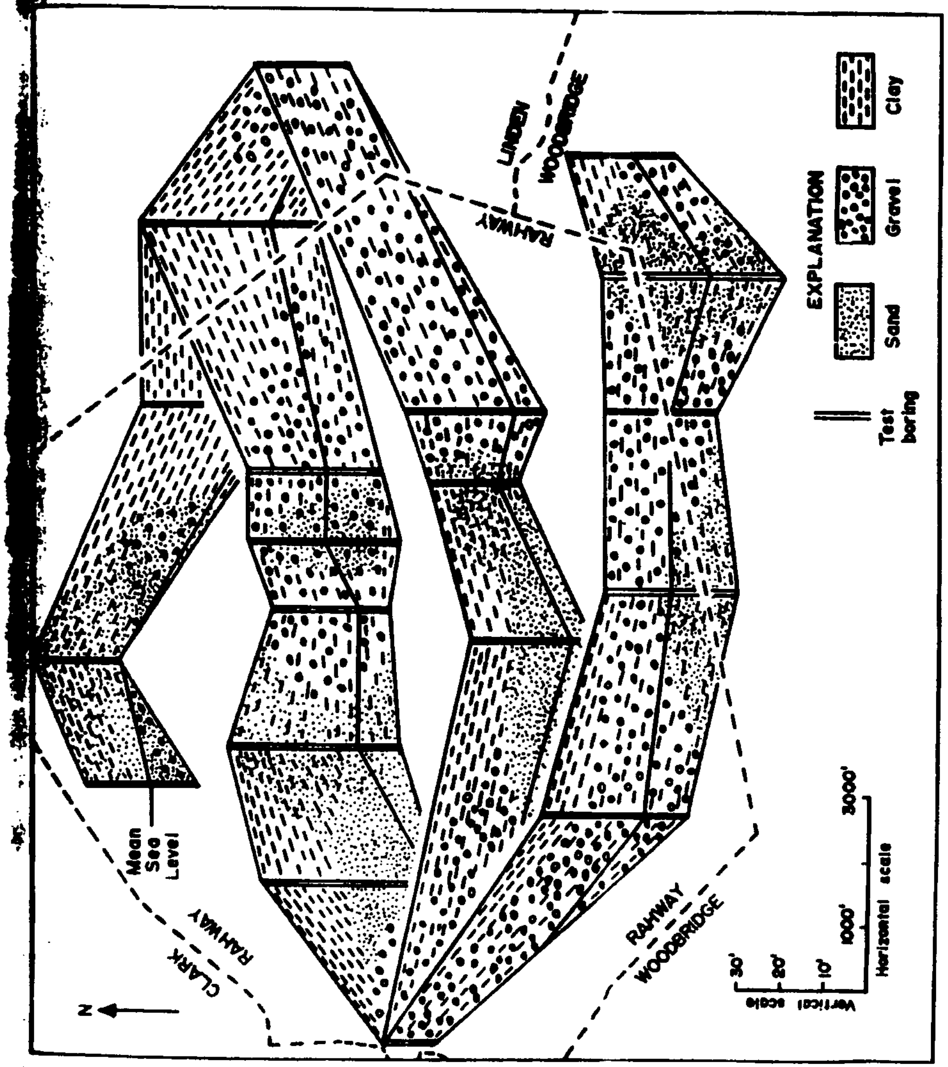


Figure 10.—Schematic fence diagram of the glacial drift underlying the city of Rahway.

REFERENCE NO. 19

ENDANGERED AND THREATENED WILDLIFE AND PLANTS

JANUARY 1, 1986

50 CFR 17.11 and 17.12

Department of the Interior
U.S. Fish and Wildlife Service

FISH AND WILDLIFE SERVICE LIST OF ENDANGERED AND THREATENED WILDLIFE AND PLANTS

(50 CFR 17.11, 17.12; As shown in Code of Federal Regulations, Volume 50, Revised as of October 1, 1983; 48 FR 46057, October 11, 1983; 48 FR 46331, 46336, 46337, 46341, October 12, 1983; 48 FR 49248, October 25, 1983; 48 FR 52742, 52746, November 22, 1983; 49 FR 1058, January 9, 1984; 49 FR 1994, January 17, 1984; 49 FR 2783, 2786, January 23, 1984; 49 FR 6102, February 17, 1984; 49 FR 7334, February 28, 1984; 49 FR 7394, 7397, February 29, 1984; 49 FR 10525, March 20, 1984; 49 FR 14356, April 11, 1984; 49 FR 21058, May 18, 1984; 49 FR 22329, 22334, May 29, 1984; 49 FR 27514, July 5, 1984; 49 FR 28565, July 13, 1984; 49 FR 29234, 29237, July 19, 1984; 49 FR 30201, July 27, 1984; 49 FR 31420, August 7, 1984; 49 FR 33885, 33892, August 27, 1984; 49 FR 34494, 34500, 34504, 34510, August 31, 1984; 49 FR 35954, September 13, 1984; 49 FR 40038, October 12, 1984; 49 FR 43069, October 26, 1984; 49 FR 43968, November 1, 1984; 49 FR 44756, November 9, 1984; 49 FR 45163, November 15, 1984; 49 FR 47400, December 4, 1984; 50 FR 1056, January 9, 1985)

Title 50—Wildlife and Fisheries

CHAPTER I—UNITED STATES FISH AND WILDLIFE SERVICE, DEPARTMENT OF THE INTERIOR

SUBCHAPTER B—TAKING, POSSESSION, TRANSPORTATION, SALE, PURCHASE, BARTER, EXPORTATION, AND IMPORTATION OF WILDLIFE

PART 17—ENDANGERED AND THREATENED WILDLIFE AND PLANTS

Authority: Pub. L. 93-205, 87 Stat. 884; Pub. L. 94-359, 90 Stat. 911; Pub. L. 95-632, 92 Stat. 3751; Pub. L. 96-159, 93 Stat. 1225; Pub. L. 97-304, 96 Stat. 1411 (16 U.S.C. 1531 *et seq.*)

[Amended by 49 FR 21058, May 18, 1984; 49 FR 22329, 22334, May 29, 1984; 49 FR 27514, July 5, 1984; 49 FR 28565, July 13, 1984; 49 FR 29234, 29237, July 19, 1984; 49 FR 30201, July 27, 1984; 49 FR 31420, August 7, 1984; 49 FR 33885, 33892, August 27, 1984; 49 FR 34494, 34500, 34504, 34510, August 31, 1984; 49 FR 35954, September 13, 1984; 49 FR 43968, November 1, 1984; 49 FR 44756, November 9, 1984; 49 FR 45163, November 15, 1984; 49 FR 47400, December 4, 1984; 50 FR 1056, January 9, 1985]

Subpart B — Lists

§17.11 Endangered and threatened wildlife.

(a) The list in this section contains the [illegible] been determined by the Services to be Endangered or Threatened. It also contains the names of species of wildlife treated as Endangered or Threatened because they are sufficiently similar in appearance to Endangered or Threatened species (see §17.50 *et seq.*).

(b) The columns entitled "Common Name," "Scientific Name," and "Vertebrate Population Where Endangered or Threatened" define the species of wildlife within the meaning of the Act. Thus, differently classified geographic populations of the same vertebrate subspecies or species shall be identified by their differing geographic boundaries, even though the other two columns are identical. The term "Entire" means that all populations throughout the present range of a vertebrate species are listed. Although common names are included, they cannot be relied upon for identification of any specimen, since they may vary greatly in local usage. The Services shall use the most recently accepted scientific name. In cases in which confusion might arise, a synonym(s) will be provided in parentheses. The Services shall rely to the extent practicable on the *International Code of Zoological Nomenclature.*

(c) In the "Status" column the following symbols are used: "E" for Endangered, "T" for Threatened, and "E [or T] (S/A)" for similarity of appearance species.

(d) The other data in the list are nonregulatory in nature and are provided for the information of the reader. In the annual revision and compilation of this Title, the following information may be amended without public notice: the spelling of species' names, historical range, footnotes, references to certain other applicable portions of this Title, synonyms, and more current names. In any of these revised entries, neither the species, as defined in paragraph (b) of this section, nor its status may be changed without following the procedures of Part 424 of this Title.

(e) The "Historic Range" indicates the known general distribution of the species or subspecies as reported in the current scientific literature. The present distribution may be greatly reduced from this historic range. This column does not imply any limitation on the application of the prohibitions in the Act or implementing rules. Such prohibitions apply to all individuals of the species, wherever found.

(f)(1) A footnote to the **Federal Register** publication(s) listing or reclassifying a species is indicated under the column "When Listed." Footnote numbers to §§17.11 and 17.12 are in the same numerical sequence, since plants and animals may be listed in the same **Federal Register** document. That document, at least since 1973, includes a statement indicating the basis for the listing, as well as the effective date(s) of said listing.

(2) The "Special Rules" and "Critical Habitat" columns provide a cross reference to other sections in Parts 17, 222, 226, or 227. The "Special Rules" column will also be used to cite the special rules that describe experimental populations and determine if they are essential or nonessential. Separate listing will be made for experimental populations, and the status column will include the following symbols: "XE" for an essential experimental population and "XN" for a nonessential experimental population. The term "NA" (not applicable) appearing in either of these two columns indicates that there are no special rules and/or Critical Habitat for that particular species. However, all other appropriate rules in Parts 17, 217-227, and 402 still apply to that species. In addition, there may be other rules in this Title that relate to such wildlife, e.g., port-of-entry requirements. It is not intended that the references in the "Special Rules" column [illegible]

Title 50—Wildlife and Fisheries

PART 17—ENDANGERED AND THREATENED WILDLIFE AND PLANTS

* * * * *

Subpart B—Lists

Source: 48 FR 34182, July 27, 1983, unless otherwise noted.

§ 17.11 Endangered and threatened wildlife.

(a) The list in this section contains the names of all species of wildlife which have been determined by the Services to be Endangered or Threatened. It also contains the names of species of wildlife treated as Endangered or Threatened because they are sufficiently similar in appearance to Endangered or Threatened species (see § 17.50 *et seq.*).

(b) The columns entitled "Common Name," "Scientific Name," and "Vertebrate Population Where Endangered or Threatened" define the species of wildlife within the meaning of the Act. Thus, differently classified geographic populations of the same vertebrate subspecies or species shall be identified by their differing geographic boundaries, even though the other two columns are identical. The term "Entire" means that all populations throughout the present range of a vertebrate species are listed. Although common names are included, they cannot be relied upon for identification of any specimen, since they may vary greatly in local usage. The Services shall use the most recently accepted scientific name. In cases in which confusion might arise, a synonym(s) will be provided in parentheses. The Services shall rely to the extent practicable on the *International Code of Zoological Nomenclature.*

(c) In the "Status" column the following symbols are used: "E" for Endangered, "T" for Threatened, and "E [or T] (S/A)" for similarity of appearance species.

(d) The other data in the list are nonregulatory in nature and are provided for the information of the reader. In the annual revision and compilation of this Title, the following information may be amended without public notice: the spelling of species' names, historical range, footnotes, references to certain other applicable portions of this Title, synonyms, and more current names. In any of these revised entries, neither the species, as defined in paragraph (b) of this section, nor its status may be changed without following the procedures of Part 424 of this Title.

(e) The "Historic Range" indicates the known general distribution of the species or subspecies as reported in the current scientific literature. The present distribution may be greatly reduced from this historic range. This column does not imply any limitation on the application of the prohibitions in the Act or implementing rules. Such prohibitions apply to all individuals of the species, wherever found.

(f)(1) A footnote to the Federal Register publication(s) listing or reclassifying a species is indicated under the column "When Listed." Footnote numbers to §§ 17.11 and 17.12 are in the same numerical sequence, since plants and animals may be listed in the same Federal Register document. That document, at least since 1973, includes a statement indicating the basis for the listing, as well as the effective date(s) of said listing.

(2) The "Special Rules" and "Critical Habitat" columns provide a cross reference to other sections in Parts 17, 222, 226, or 227. The "Special Rules" column will also be used to cite the special rules that describe experimental populations and determine if they are essential or nonessential. Separate listing will be made for experimental populations, and the status column will include the following symbols: "XE" for an essential experimental population and "XN" for a nonessential experimental population. The term "NA" (not applicable) appearing in either of these two columns indicates that there are no special rules and/or critical habitat for that particular species. However, all other appropriate rules in Parts 17, 217–227, and 402 still apply to that species. In addition, there may be other rules in this Title that relate to such wildlife, e.g., port-of-entry requirements. It is not intended that the references in the "Special Rules" column list all the regulations of the two Services which might apply to the species or to the regulations of other Federal agencies or State or local governments.

(g) The listing of a particular taxon includes all lower taxonomic units. For example, the genus *Hylobates* (gibbons) is listed as Endangered throughout its entire range (China, India, and SE Asia); consequently, all species, subspecies, and populations of that genus are considered listed as Endangered for the purposes of the Act. In 1978 (43 FR 6230–6233) the species *Haliaeetus leucocephalus* (bald eagle) was listed as Threatened in "USA (WA, OR, MN, WI, MI)" rather than its entire population; thus, all individuals of the bald eagle found in those five States are considered listed as Threatened for the purposes of the Act.

(h) The "List of Endangered and Threatened Wildlife" is provided below:

EDITORIAL NOTE: This is a compilation and special reprint of 50 CFR 17.11 and 17.12 and is current as of the date shown on the cover. Minor changes and corrections to the October 1, 1988, compilation of 50 CFR have been incorporated in this printing, as well as all published final rules that have subsequently appeared in the Federal Register. Otherwise, no entry in these lists has been significantly affected. This list has been prepared by the staff of the Office of Endangered Species, U.S. Fish and Wildlife Service, Washington, D.C. 20240. Readers are requested to advise the Service of any errors in this list. Copies are available from the Publication Unit, U.S. Fish and Wildlife Service, Washington, D.C. 20240.

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Caribou, woodland	*Rangifer tarandus caribou*	Canada, U.S.A. (AK, ID, ME, MI, MN, MT, NH, VT, WA, WI).	Canada (that part of S.E. Brit. Col. bounded by the Can.-USA border, Columbia R., Kootenay R., Kootenay L., and Kootenai R.), U.S.A. (ID, WA).	E	128E, 136E, 143	NA	NA
Cat, Andean	*Felis jacobita*	Chile, Peru, Bolivia, Argentina	Entire	E	15	NA	NA
Cat, black-footed	*Felis nigripes*	Southern Africa	do	E	15	NA	NA
Cat, flat-headed	*Felis planiceps*	Malaysia, Indonesia	do	E	15	NA	NA
Cat, Iriomote	*Felis (Mayailurus) iriomotensis*	Japan (Iriomote Island, Ryukyu Islands)	do	E	15	NA	NA
Cat, leopard	*Felis bengalensis bengalensis*	India, Southeast Asia	do	E	50	NA	NA
Cat, marbled	*Felis marmorata*	Nepal, Southeast Asia, Indonesia	do	E	15	NA	NA
Cat, Pakistan sand	*Felis margarita scheffeli*	Pakistan	do	E	139	NA	NA
Cat, Temminck's (=golden cat)	*Felis temmincki*	Nepal, China, Southeast Asia, Indonesia (Sumatra).	do	E	15	NA	NA
Cat, tiger	*Felis tigrinus*	Costa Rica to northern Argentina	do	E	5	NA	NA
Chamois, Apennine	*Rupicapra rupicapra ornata*	Italy	do	E	15	NA	NA
Cheetah	*Acinonyx jubatus*	Africa to India	do	E	3, 5	NA	NA
Chimpanzee	*Pan troglodytes*	West and Central Africa	do	T	16	NA	17.40(c)
Chimpanzee, pygmy	*Pan paniscus*	Zaire	do	T	16	NA	17.40(c)
Chinchilla	*Chinchilla brevicaudata boliviana*	Bolivia	do	E	15	NA	NA
Civet, Malabar large-spotted	*Viverra megaspila civettina*	India	do	E	50	NA	NA
Cochito (=Gulf of California harbor porpoise).	*Phocoena sinus*	Mexico (Gulf of California)	do	E	169	NA	NA
Colobus, Preuss's red	*Colobus badius preussi*	Cameroon	do	E	139	NA	NA
Cougar, eastern	*Felis concolor cougar*	Eastern North America	do	E	6	NA	NA
Deer, Bactrian	*Cervus elaphus bactrianus*	U.S.S.R., Afghanistan	do	E	50	NA	NA
Deer, Bawean	*Axis (=Cervus) porcinus kuhli*	Indonesia	do	E	3	NA	NA
Deer, Barbary	*Cervus elaphus barbarus*	Morocco, Tunisia, Algeria	do	E	50	NA	NA
Deer, Cedros Island mule	*Odocoileus hemionus cedrosensis*	Mexico (Cedros Island)	do	E	10	NA	NA
Deer, Columbian white-tailed	*Odocoileus virginianus leucurus*	U.S.A. (WA, OR)	do	E	1	NA	NA
Deer, Corsican red	*Cervus elaphus corsicanus*	Corsica, Sardinia	do	E	50	NA	NA
Deer, Eld's brow-antlered	*Cervus eldi*	India to Southeast Asia	do	E	3	NA	NA
Deer, Formosan sika	*Cervus nippon taiouanus*	Taiwan	do	E	50	NA	NA
Deer, hog	*Axis (=Cervus) porcinus annamiticus*	Thailand, Indochina	do	E	15	NA	NA
Deer, key	*Odocoileus virginianus clavium*	U.S.A. (FL)	do	E	1	NA	NA
Deer, marsh	*Blastocerus dichotomus*	Argentina, Uruguay, Paraguay, Bolivia, Brazil.	do	E	3	NA	NA
Deer, McNeill's	*Cervus elaphus macneilli*	China (Sinkiang, Tibet)	do	E	3	NA	NA
Deer, musk	*Moschus* spp. (all species)	Central and East Asia	Afghanistan, Bhutan, Burma, China (Tibet, Yunnan), India, Nepal, Pakistan, Sikkim.	E	15	NA	NA
Deer, North China sika	*Cervus nippon mandarinus*	China (Shantung and Chihli Provinces)	Entire	E	50	NA	NA
Deer, pampas	*Ozotoceros bezoarticus*	Brazil, Argentina, Uruguay, Bolivia, Paraguay.	do	E	15	NA	NA

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
Jaguarundi	*Felis yagouaroundi cacomitli*	U.S.A. (TX), Mexico	Entire	E	15	NA	NA
Jaguarundi	*Felis yagouaroundi fossata*	Mexico, Nicaragua	do	E	15	NA	NA
Jaguarundi	*Felis yagouaroundi panamensis*	Nicaragua, Costa Rica, Panama	do	E	15	NA	NA
Jaguarundi	*Felis yagouaroundi tolteca*	U.S.A. (AZ), Mexico	do	E	15	NA	NA
Kangaroo, eastern gray	*Macropus giganteus* (all subspecies except *tasmaniensis*).	Australia	do	T	7	NA	17.40(a)
Kangaroo, red	*Macropus (Megaleia) rufus*	do	do	T	7	NA	17.40(a)
Kangaroo, Tasmanian forester	*Macropus giganteus tasmaniensis*	Australia (Tasmania)	do	E	6	NA	NA
Kangaroo, western gray	*Macropus fuliginosus*	Australia	do	T	7	NA	17.40(a)
Kouprey	*Bos sauveli*	Vietnam, Laos, Cambodia, Thailand	do	E	3	NA	NA
Langur, capped	*Presbytis pileata*	India, Burma, Bangladesh	do	E	15	NA	NA
Langur, entellus	*Presbytis entellus*	China (Tibet), India, Pakistan, Kashmir, Sri Lanka, Sikkim, Bangladesh.	do	E	15	NA	NA
Langur, Douc	*Pygathrix nemaeus*	Cambodia, Laos, Vietnam	do	E	3	NA	NA
Langur, Francois'	*Presbytis francoisi*	China (Kwangsi), Indochina	do	E	16	NA	NA
Langur, golden	*Presbytis geei*	India (Assam), Bhutan	do	E	15	NA	NA
Langur, long-tailed	*Presbytis potenziani*	Indonesia	do	T	16	NA	17.40(c)
Langur, Pagi Island	*Nasalis (Simias) concolor*	do	do	E	3	NA	NA
Langur, purple-faced	*Presbytis senex*	Sri Lanka (=Ceylon)	do	T	16	NA	17.40(c)
Langur, Tonkin snub-nosed	*Pygathrix (Rhinopithecus) avunculus*	Vietnam	do	T	16	NA	17.40(c)
Lechwe, red	*Kobus leche*	Southern Africa	do	T	3, 15, 106	NA	NA
Lemurs	Lemuridae (incl. Cheirogaleidae, Lepilemuridae); all members of genera *Lemur, Phaner, Hapalemur, Lepilemur, Microcebus, Allocebus, Cheirogaleus, Varecia*.	Malagasy Republic (=Madagascar)	do	E	3, 15	NA	NA
Leopard	*Panthera pardus*	Africa, Asia	Wherever found, except where it is listed as Threatened as set forth below.	E	3, 5, 114	NA	NA
Do	do	do	In Africa, in the wild, south of, and including, the following countries: Gabon, Congo, Zaire, Uganda, Kenya.	T	3, 5, 114	NA	17.40(f)
Leopard, clouded	*Neofelis nebulosa*	Southeast and south-central Asia, Taiwan.	Entire	E	3, 15	NA	NA
Leopard, snow	*Panthera uncia*	Central Asia	do	E	5	NA	NA
Linsang, spotted	*Prionodon pardicolor*	Nepal, Assam, Vietnam, Cambodia, Laos, Burma.	do	E	15	NA	NA
Lion, Asiatic	*Panthera leo persica*	Turkey to India	do	E	3	NA	NA
Loris, lesser slow	*Nycticebus pygmaeus*	Indochina	do	T	16	NA	17.40(c)
Lynx, Spanish	*Felis (=Lynx) pardina*	Spain, Portugal	do	E	3	NA	NA
Macaque, Formosan rock	*Macaca cyclopis*	Taiwan	do	T	16	NA	17.40(c)
Macaque, Japanese	*Macaca fuscata*	Japan (Shikoku, Kyushu and Honshu Islands).	do	T	16	NA	17.40(c)
Macaque, lion-tailed	*Macaca silenus*	India	do	E	3	NA	NA
Macaque, stump-tailed	*Macaca arctoides*	India (Assam) to southern China	do	T	16	NA	17.40(c)

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Muntjac, Fea's	*Muntiacus feae*	Northern Thailand, Burma	do	E	50	NA	NA
Native-cat, eastern	*Dasyurus viverrinus*	Australia	do	E	6	NA	NA
Numbat	*Myrmecobius fasciatus*	do	do	E	4, 6	NA	NA
Ocelot	*Felis pardalis*	U.S.A. (AZ, TX) to C. and S. America	do	E	5, 119	NA	NA
Orangutan	*Pongo pygmaeus*	Borneo, Sumatra	do	E	3	NA	NA
Oryx, Arabian	*Oryx leucoryx*	Arabian Peninsula	do	E	3	NA	NA
Otter, Cameroon clawless	*Aonyx (Paraonyx) congica microdon*	Cameroon, Nigeria	do	E	3	NA	NA
Otter, giant	*Pteronura brasiliensis*	South America	do	E	3	NA	NA
Otter, long-tailed	*Lutra longicaudis* (incl. *platensis*)	do	do	E	3, 15	NA	NA
Otter, marine	*Lutra felina*	Peru south to Straits of Magellan	do	E	15	NA	NA
Otter, southern river	*Lutra provocax*	Chile, Argentina	do	E	15	NA	NA
Otter, southern sea	*Enhydra lutris nereis*	West coast U.S.A. (WA, OR, CA) south to Mexico (Baja California).	do	T	21	NA	NA
Panda, giant	*Ailuropoda melanoleuca*	People's Republic of China	do	E	139	NA	NA
Pangolin (=scaly anteater)	*Manis temmincki*	Africa	do	E	15	NA	NA
Panther, Florida	*Felis concolor coryi*	U.S.A. (LA and AR east to SC and FL)	do	E	1	NA	NA
Planigale, little	*Planigale ingrami subtilissima* (formerly *P. subtilissima*).	Australia	do	E	4	NA	NA
Planigale, southern	*Planigale tenuirostris*	do	do	E	4	NA	NA
Porcupine, thin-spined	*Chaetomys subspinosus*	Brazil	do	E	3	NA	NA
Possum, mountain pygmy	*Burramys parvus*	Australia	do	E	4	NA	NA
Possum, scaly-tailed	*Wyulda squamicaudata*	do	do	E	4	NA	NA
Prairie dog, Mexican	*Cynomys mexicanus*	Mexico	do	E	3	NA	17.40(g)
Prairie dog, Utah	*Cynomys parvidens*	U.S.A. (UT)	do	T	6, 149	NA	NA
Pronghorn, peninsular	*Antilocapra americana peninsularis*	Mexico (Baja California)	do	E	10	NA	NA
Pronghorn, Sonoran	*Antilocapra americana sonoriensis*	U.S.A. (AZ), Mexico	do	E	1, 3	NA	NA
Pudu	*Pudu pudu*	Southern South America	do	E	15	NA	NA
Puma, Costa Rican	*Felis concolor costaricensis*	Nicaragua, Panama, Costa Rica	do	E	15	NA	NA
Quokka	*Setonix brachyurus*	Australia	do	E	6	NA	NA
Rabbit, Ryukyu	*Pentalagus furnessi*	Japan (Ryukyu Islands)	do	E	50	NA	NA
Rabbit, volcano	*Romerolagus diazi*	Mexico	do	E	3	NA	NA
Rat, false water	*Xeromys myoides*	Australia	do	E	4	NA	NA
Rat, Fresno kangaroo	*Dipodomys nitratoides exilis*	U.S.A. (CA)	do	E	170	17.95(a)	NA
Rat, Morro Bay kangaroo	*Dipodomys heermanni morroensis*	do	do	E	2	17.95(a)	NA
Rat, stick-nest	*Leporillus conditor*	Australia	do	E	6	NA	NA
Rat-kangaroo, brush-tailed	*Bettongia penicillata*	do	do	E	4	NA	NA
Rat-kangaroo, Gaimard's	*Bettongia gaimardi*	do	do	E	6	NA	NA
Rat-kangaroo, Lesuer's	*Bettongia lesueur*	do	do	E	4	NA	NA
Rat-kangaroo, plain	*Caloprymnus campestris*	do	do	E	4	NA	NA
Rat-kangaroo, Queensland	*Bettongia tropica*	do	do	E	4	NA	NA
Rhinoceros, black	*Diceros bicornis*	Sub-Saharan Africa	do	E	97	NA	NA
Rhinoceros, great Indian	*Rhinoceros unicornis*	India, Nepal	do	E	4	NA	NA
Rhinoceros, Javan	*Rhinoceros sondaicus*	Indonesia, Indochina, Burma, Thailand, Sikkim, Bangladesh, Malaysia.	do	E	3	NA	NA
Rhinoceros, northern white	*Ceratotherium simum cottoni*	Zaire, Sudan, Uganda, Central African Republic.	do	E	3	NA	NA
Rhinoceros, Sumatran	*Dicerorhinus (=Didermoceros) sumatrensis*.	Bangladesh to Vietnam to Indonesia (Borneo).	do	E	3	NA	NA
Saiga, Mongolian (antelope)	*Saiga tatarica mongolica*	Mongolia	do	E	15	NA	NA
Saki, white-nosed	*Chiropotes albinasus*	Brazil	do	E	3	NA	NA
Seal, Caribbean monk	*Monachus tropicalis*	Caribbean Sea, Gulf of Mexico	do	E	1, 2, 45	NA	NA
Seal, Guadalupe fur	*Arctocephalus townsendi*	U.S.A. (Farallon Islands, CA) south to Mexico (Islas Revillagigedo).	do	T	212	NA	227.11

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Whale, bowhead	*Balaena mysticetus*	Oceanic (north latitudes only)	do	E	3	NA	NA
Whale, finback	*Balaenoptera physalus*	Oceanic	do	E	3	NA	NA
Whale, gray	*Eschrichtius robustus*	North Pacific Ocean: coastal and Bering Sea.	do	E	3	NA	NA
Whale, humpback	*Megaptera novaeangliae*	Oceanic	do	E	3	NA	NA
Whale, right	*Balaena glacialis*	do	do	E	3	NA	NA
Whale, Sei	*Balaenoptera borealis*	do	do	E	3	NA	NA
Whale, sperm	*Physeter catodon*	do	do	E	3	NA	NA
Wolf, gray	*Canis lupus*	Holarctic	U.S.A. (48 conterminous States, except MN), Mexico.	E	1, 6, 13, 15, 35	17.95(a)	NA
Do	do	do	U.S.A. (MN)	T	35	17.95(a)	17.40(d)
Wolf, maned	*Chrysocyon brachyurus*	Argentina, Bolivia, Brazil, Paraguay, Uruguay.	Entire	E	4	NA	NA
Wolf, red	*Canis rufus*	U.S.A. (southeastern U.S.A. west to central TX).	do	E	1	NA	NA
Wombat, hairy-nosed (=Barnard's and Queensland hairy-nosed).	*Lasiorhinus krefftii* (formerly *L. barnardi* and *L. gillespiei*).	Australia	do	E	4, 6	NA	NA
Woodrat, Key Largo	*Neotoma floridana smalli*	U.S.A. (FL)	do	E	131E, 160	NA	NA
Yak, wild	*Bos grunniens*	China (Tibet), India	do	E	3	NA	NA
Zebra, Grevy's	*Equus grevyi*	Kenya, Ethiopia, Somalia	do	T	54	NA	NA
Zebra, Hartmann's mountain	*Equus zebra hartmannae*	Namibia, Angola	do	T	54, 111	NA	NA
Zebra, mountain	*Equus zebra zebra*	South Africa	do	E	15, 111	NA	NA
BIRDS							
Akepa, Hawaii (honeycreeper)	*Loxops coccineus coccineus*	U.S.A. (HI)	do	E	2	NA	NA
Akepa, Maui (honeycreeper)	*Loxops coccineus ochraceus*	do	do	E	2	NA	NA
Akialoa, Kauai (honeycreeper)	*Hemignathus procerus*	do	do	E	1	NA	NA
Akiapolaau (honeycreeper)	*Hemignathus munroi* (=*wilsoni*)	do	do	E	1	NA	NA
Albatross, short-tailed	*Diomedea albatrus*	North Pacific Ocean: Japan, U.S.S.R., U.S.A. (AK, CA, HI, OR, WA).	Entire, except U.S.A.	E	3	NA	NA
Blackbird, yellow-shouldered	*Agelaius xanthomus*	U.S.A. (PR)	Entire	E	17	17.95(b)	NA
Bobwhite, masked (quail)	*Colinus virginianus ridgwayi*	U.S.A. (AZ), Mexico (Sonora)	do	E	1, 3	NA	NA
Booby, Abbott's	*Sula abbotti*	Indian Ocean: Christmas Island	do	E	15	NA	NA
Bristlebird, western	*Dasyornis brachypterus longirostris*	Australia	do	E	3	NA	NA
Bristlebird, western rufous	*Dasyornis broadbenti littoralis*	do	do	E	15	NA	NA
Broadbill, Guam	*Myiagra freycineti*	Western Pacific Ocean: U.S.A. (Guam)	do	E	156	NA	NA
Bulbul, Mauritius olivaceous	*Hypsipetes borbonicus olivaceus*	Indian Ocean: Mauritius	do	E	3	NA	NA
Bullfinch, Sao Miguel (finch)	*Pyrrhula pyrrhula murina*	Eastern Atlantic Ocean: Azores	do	E	3	NA	NA
Bushwren, New Zealand	*Xenicus longipes*	New Zealand	do	E	3	NA	NA
Bustard, great Indian	*Choriotis nigriceps*	India, Pakistan	do	E	3	NA	NA
Cahow (=Bermuda Petrel)	*Pterodroma cahow*	North Atlantic Ocean: Bermuda	do	E	3	NA	NA
Condor, Andean	*Vultur gryphus*	Colombia to Chile and Argentina	do	E	4	NA	NA
Condor, California	*Gymnogyps californianus*	U.S.A. (OR, CA), Mexico (Baja California).	do	E	1	17.95(b)	NA
Coot, Hawaiian (=alae keo keo)	*Fulica americana alai*	U.S.A. (HI)	do	E	2	NA	NA
Cotinga, banded	*Cotinga maculata*	Brazil	do	E	15	NA	NA
Cotinga, white-winged	*Xipholena atropurpurea*	do	do	E	15	NA	NA
Crane, black-necked	*Grus nigricollis*	China (Tibet)	do	E	15	NA	NA
Crane, Cuba sandhill	*Grus canadensis nesiotes*	West Indies: Cuba	do	E	15	NA	NA
Crane, hooded	*Grus monacha*	Japan, U.S.S.R	do	E	4	NA	NA

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Finch, Laysan (honeycreeper)	*Telespyza* (= *Psittirostra*) *cantans*	U.S.A. (HI)	Entire	E	1	NA	NA
Finch, Nihoa (honeycreeper)	*Telespyza* (= *Psittirostra*) *ultima*	do	do	E	1	NA	NA
Flycatcher, Euler's	*Empidonax euleri johnstonei*	West Indies: Grenada	do	E	3	NA	NA
Flycatcher, Seychelles paradise	*Terpsiphone corvina*	Indian Ocean: Seychelles	do	E	3	NA	NA
Flycatcher, Tahiti	*Pomarea nigra*	South Pacific Ocean: Tahiti	do	E	3	NA	NA
Fody, Seychelles (weaver-finch)	*Foudia sechellarum*	Indian Ocean: Seychelles	do	E	3	NA	NA
Frigatebird, Andrew's	*Fregata andrewsi*	East Indian Ocean	do	E	15	NA	NA
Goose, Aleutian Canada	*Branta canadensis leucopareia*	U.S.A. (AK, CA, OR, WA), Japan	do	E	1, 3	NA	NA
Goose, Hawaiian (=nene)	*Nesochen* (= *Branta*) *sandvicensis*	U.S.A. (HI)	do	E	1	NA	NA
Goshawk, Christmas Island	*Accipiter fasciatus natalis*	Indian Ocean: Christmas Island	do	E	3	NA	NA
Grackle, slender-billed	*Quiscalus* (= *Cassidix*) *palustris*	Mexico	do	E	3	NA	NA
Grasswren, Eyrean (flycatcher)	*Amytornis goyderi*	Australia	do	E	3	NA	NA
Grebe, Atitlan	*Podilymbus gigas*	Guatemala	do	E	3	NA	NA
Greenshank, Nordmann's	*Tringa guttifer*	U.S.S.R., Japan, south to Malaya, Borneo.	do	E	15	NA	NA
Guan, horned	*Oreophasis derbianus*	Guatemala, Mexico	do	E	3	NA	NA
Gull, Audouin's	*Larus audouinii*	Mediterranean Sea	do	E	3	NA	NA
Gull, relict	*Larus relictus*	India, China	do	E	15	NA	NA
Hawk, Anjouan Island sparrow	*Accipiter francesii pusillus*	Indian Ocean: Comoro Islands	do	E	3	NA	NA
Hawk, Galapagos	*Buteo galapagoensis*	Ecuador (Galapagos Islands)	do	E	3	NA	NA
Hawk, Hawaiian (= io)	*Buteo solitarius*	U.S.A. (HI)	do	E	1	NA	NA
Hermit, hook-billed (hummingbird)	*Glaucis* (= *Ramphodon*) *dohrnii*	Brazil	do	E	15	NA	NA
Honeycreeper, crested (= 'akohekohe)	*Palmeria dolei*	U.S.A. (HI)	do	E	1	NA	NA
Hornbill, helmeted	*Rhinoplax vigil*	Thailand, Malaysia	do	E	15	NA	NA
Honeyeater, helmeted	*Meliphaga cassidix*	Australia	do	E	4	NA	NA
Ibis, Japanese crested	*Nipponia nippon*	China, Japan, U.S.S.R., Korea	do	E	3	NA	NA
Kagu	*Rhynochetos jubatus*	South Pacific Ocean: New Caledonia	do	E	3	NA	NA
Kakapo (= owl-parrot)	*Strigops habroptilus*	New Zealand	do	E	3	NA	NA
Kestrel, Mauritius	*Falco punctatus*	Indian Ocean: Mauritius	do	E	3	NA	NA
Kestrel, Seychelles	*Falco araea*	Indian Ocean: Seychelles Islands	do	E	3	NA	NA
Kingfisher, Guam Micronesian	*Halcyon cinnamomina cinnamomina*	Western Pacific Ocean: U.S.A. (Guam)	do	E	156	NA	NA
Kite, Cuba hook-billed	*Chondrohierax uncinatus wilsonii*	West Indies: Cuba	do	E	3	NA	NA
Kite, Grenada hook-billed	*Chondrohierax uncinatus mirus*	West Indies: Grenada	do	E	3	NA	NA
Kite, Everglade snail	*Rostrhamus sociabilis plumbeus*	U.S.A. (FL)	do	E	1	17.95(b)	NA
Kokako (wattlebird)	*Callaeas cinerea*	New Zealand	do	E	3	NA	NA
Macaw, glaucous	*Anodorhynchus glaucus*	Paraguay, Uruguay, Brazil	do	E	15	NA	NA
Macaw, indigo	*Anodorhynchus leari*	Brazil	do	E	15	NA	NA
Macaw, little blue	*Cyanopsitta spixii*	do	do	E	15	NA	NA
Magpie-robin, Seychelles (thrush)	*Copsychus sechellarum*	Indian Ocean: Seychelles Islands	do	E	3	NA	NA
Malkoha, red-faced (cuckoo)	*Phaenicophaeus pyrrhocephalus*	Sri Lanka (= Ceylon)	do	E	3	NA	NA
Mallard, Mariana	*Anas oustaleti*	West Pacific Ocean: U.S.A. (Guam, Mariana Islands).	do	E	23	NA	NA
Megapode, Micronesian (= La Perouse's).	*Megapodius laperouse*	West Pacific Ocean: U.S.A. (Palau Island, Mariana Islands).	do	E	3	NA	NA
Megapode, Maleo	*Macrocephalon maleo*	Indonesia (Celebes)	do	E	3	NA	NA
Millerbird, Nihoa (old world warbler)	*Acrocephalus familiaris kingi*	U.S.A. (HI)	do	E	1	NA	NA
Monarch, Tinian (old world flycatcher)	*Monarcha takatsukasae*	Western Pacific Ocean: U.S.A. (Mariana Islands).	do	E	3	NA	NA
Moorhen (= gallinule), Hawaiian common.	*Gallinula chloropus sandvicensis*	U.S.A. (HI)	do	E	1	NA	NA
Moorhen (= gallinule), Mariana common	*Gallinula chloropus guami*	Western Pacific Ocean: U.S.A. (Guam, Tinian, Saipan, Pagan).	do	E	156	NA	NA
Nightjar (= whip-poor-will), Puerto Rico	*Caprimulgus noctitherus*	U.S.A. (PR)	do	E	6	NA	NA

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Pheasant, white eared	*Crossoptilon crossoptilon*	China (Tibet), India	do	E	4	NA	NA
Pigeon, Azores wood	*Columba palumbus azorica*	East Atlantic Ocean: Azores	do	E	3	NA	NA
Pigeon, Chatham Island	*Hemiphaga novaeseelandiae chathamensis*	New Zealand	do	E	3	NA	NA
Pigeon, Mindoro zone-tailed	*Ducula mindorensis*	Philippines	do	E	15	NA	NA
Pigeon, Puerto Rican plain	*Columba inornata wetmorei*	U.S.A. (PR)	do	E	2	NA	NA
Piping-guan, black-fronted	*Pipile jacutinga*	Argentina	do	E	15	NA	NA
Pitta, Koch's	*Pitta kochi*	Philippines	do	E	15	NA	NA
Plover, New Zealand shore	*Thinornis novaeseelandiae*	New Zealand	do	E	3	NA	NA
Plover, piping	*Charadrius melodus*	U.S.A. (Great Lakes, northern Great Plains, Atlantic and Gulf Coasts, PR, VI), Canada, Mexico, Bahamas, West Indies.	Great Lakes watershed in States of IL, IN, MI, MN, NY, OH, PA, and WI and Province of Ontario.	E	211	NA	NA
Do	do	do	Entire, except those areas where listed as endangered above.	T	211	NA	NA
Po'ouli (honeycreeper)	*Melamprosops phaeosoma*	U.S.A. (HI)	do	E	10	NA	NA
Prairie-chicken, Attwater's greater	*Tympanuchus cupido attwateri*	U.S.A. (TX)	do	E	1	NA	NA
Quail, Merriam's Montezuma	*Cyrtonyx montezumae merriami*	Mexico (Vera Cruz)	do	E	15	NA	NA
Quetzal, resplendent	*Pharomachrus mocinno*	Mexico to Panama	do	E	15	NA	NA
Rail, Auckland Island	*Rallus pectoralis muelleri*	New Zealand	do	E	3	NA	NA
Rail, California clapper	*Rallus longirostris obsoletus*	U.S.A. (CA)	do	E	2	NA	NA
Rail, Guam	*Rallus owstoni*	Western Pacific Ocean: U.S.A. (Guam)	do	E	146E, 156	NA	NA
Rail, light-footed clapper	*Rallus longirostris levipes*	U.S.A. (CA), Mexico (Baja California)	do	E	2	NA	NA
Rail, Lord Howe wood	*Tricholimnas sylvestris*	Australia (Lord Howe Island)	do	E	15	NA	NA
Rail, Yuma clapper	*Rallus longirostris yumanensis*	Mexico, U.S.A. (AZ, CA)	do	E	1	NA	NA
Rhea, Darwin's	*Pterocnemia pennata*	Argentina, Bolivia, Peru, Uruguay	do	E	3	NA	NA
Robin, Chatham Island	*Petroica traversi*	New Zealand	do	E	3	NA	NA
Robin, scarlet-breasted (flycatcher)	*Petroica multicolor multicolor*	Australia (Norfolk Island)	do	E	3	NA	NA
Rockfowl, grey-necked	*Picathartes oreas*	Cameroon, Gabon	do	E	3	NA	NA
Rockfowl, white-necked	*Picathartes gymnocephalus*	Africa: Togo to Sierra Leone	do	E	3	NA	NA
Roller, long-tailed ground	*Uratelornis chimaera*	Malagasy Republic (=Madagascar)	do	E	3	NA	NA
Scrub-bird, noisy	*Atrichornis clamosus*	Australia	do	E	3	NA	NA
Shama, Cebu black (thrush)	*Copsychus niger cebuensis*	Philippines	do	E	3	NA	NA
Shearwater, Newell's Townsend's (formerly Manx) (='A'o)	*Puffinus auricularis* (formerly *puffinus*) *newelli*	U.S.A. (HI)	do	T	10	NA	NA
Shrike, San Clemente loggerhead	*Lanius ludovicianus mearnsi*	U.S.A. (CA)	do	E	26	NA	NA
Siskin, red	*Carduelis (=Spinus) cucullata*	South America	do	E	15	NA	NA
Sparrow, Cape Sable seaside	*Ammodramus (=Ammospiza) maritimus mirabilis*	U.S.A. (FL)	do	E	1	17.95(b)	NA
Sparrow, dusky seaside	*Ammodramus (=Ammospiza) maritimus nigrescens*	do	do	E	1	17.95(b)	NA
Sparrow, San Clemente sage	*Amphispiza belli clementeae*	U.S.A. (CA)	do	T	26	NA	NA
Starling, Ponape mountain	*Aplonis pelzelni*	West Pacific Ocean: U.S.A. (Caroline Islands)	do	E	3	NA	NA
Starling, Rothschild's (myna)	*Leucopsar rothschildi*	Indonesia (Bali)	do	E	3	NA	NA
Stilt, Hawaiian (=Ae'o)	*Himantopus himantopus knudseni*	U.S.A. (HI)	do	E	2	NA	NA

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Stork, oriental white	*Ciconia ciconia boyciana*	China, Japan, Korea, U.S.S.R	...do	E	3	NA	NA
Stork, wood	*Mycteria americana*	U.S.A., (CA, AZ, TX, to Carolinas), Mexico, Central and South America.	U.S.A. (AL, FL, GA, SC).	E	142	NA	NA
Swiftlet, Vanikoro	*Aerodramus (=Collocalia) vanikorensis bartschi.*	Western Pacific Ocean: U.S.A. (Guam, Rota, Tinian, Saipan, Agiguan).	Entire	E	156	NA	NA
Teal, Campbell Island flightless	*Anas aucklandica nesiotis*	New Zealand (Campbell Island)	...do	E	15	NA	NA
Tern, California least	*Sterna antillarum (=albifrons) browni*	Mexico, U.S.A. (CA)	...do	E	2, 3	NA	NA
Tern, least	*Sterna antillarum*	U.S.A. (Atlantic and Gulf coasts, Miss. R. Basin, CA), Gr. and Lesser Antilles, Bahamas, Mexico; winters C. America, northern S. America.	U.S.A. [AR, CO, IA, IL, IN, KS, KY, LA (Miss. R. and tribs. N of Baton Rouge), MS (Miss. R.), MO, MT, NE, NM, ND, OK, SD, TN, TX (Except within 50 miles of coast)].	E	182	NA	NA
Thrasher, white-breasted	*Ramphocinclus brachyurus*	West Indies: St. Lucia, Martinique	Entire	E	3	NA	NA
Thrush, large Kauai	*Myadestes (=Phaeornis) myadestinus*	U.S.A. (HI)	...do	E	2	NA	NA
Thrush, Molokai (=oloma'o)	*Myadestes (=Phaeornis) lanaiensis (=obscurus) rutha.*	...do	...do	E	2	NA	NA
Thrush, New Zealand (wattlebird)	*Turnagra capensis*	New Zealand	...do	E	3	NA	NA
Thrush, small Kauai (=puaiohi)	*Myadestes (=Phaeornis) palmeri*	U.S.A. (HI)	...do	E	1	NA	NA
Tinamou, solitary	*Tinamus solitarius*	Brazil, Paraguay, Argentina	...do	E	15	NA	NA
Trembler, Martinique (thrasher)	*Cinclocerthia ruficauda gutturalis*	West Indies: Martinique	...do	E	3	NA	NA
Wanderer, plain (collared-hemipode)	*Pedionomus torquatus*	Australia	...do	E	6	NA	NA
Warbler (wood), Bachman's	*Vermivora bachmanii*	U.S.A.(Southeastern), Cuba	...do	E	1, 3	NA	NA
Warbler (wood), Barbados yellow	*Dendroica petechia petechia*	West Indies: Barbados	...do	E	3	NA	NA
Warbler (wood), Kirtland's	*Dendroica kirtlandii*	U.S.A. (principally MI), Canada, West Indies: Bahama Islands.	...do	E	1, 3	NA	NA
Warbler (willow), nightingale reed	*Acrocephalus luscinia*	Western Pacific Ocean	U.S.A. (Mariana Islands).	E	3, 4	NA	NA
Warbler (willow), Rodrigues	*Bebrornis rodericanus*	Mauritius (Rodrigues Islands)	Entire	E	3	NA	NA
Warbler (wood), Semper's	*Leucopeza semperi*	West Indies: St. Lucia	...do	E	3	NA	NA
Warbler (willow), Seychelles	*Bebrornis sechellensis*	Indian Ocean: Seychelles Island	...do	E	3	NA	NA
Whipbird, Western	*Psophodes nigrogularis*	Australia	...do	E	3	NA	NA
White-eye, bridled	*Zosterops conspicillata conspicillata*	Western Pacific Ocean: U.S.A. (Guam)	...do	E	156	NA	NA
White-eye, Norfolk Island	*Zosterops albogularis*	Indian Ocean: Norfolk Islands	...do	E	15	NA	NA
White-eye, Ponape greater	*Rukia longirostra (=sanfordi)*	West Pacific Ocean: U.S.A. (Caroline Islands).	...do	E	3	NA	NA
White-eye, Seychelles	*Zosterops modesta*	Indian Ocean: Seychelles	...do	E	3	NA	NA
Woodpecker, imperial	*Campephilus imperialis*	Mexico	...do	E	3	NA	NA
Woodpecker, ivory-billed	*Campephilus principalis*	U.S.A. (southcentral and southeastern), Cuba.	...do	E	1, 3	NA	NA
Woodpecker, red-cockaded	*Picoides (=Dendrocopos) borealis*	U.S.A. (southcentral and southeastern)	...do	E	2	NA	NA
Woodpecker, Tristram's	*Dryocopus javensis richardsi*	Korea	...do	E	3	NA	NA
Wren, Guadeloupe house	*Troglodytes aedon guadeloupensis*	West Indies: Guadeloupe	...do	E	3	NA	NA
Wren, St. Lucia house	*Troglodytes aedon mesoleucus*	West Indies: St. Lucia	...do	E	3	NA	NA

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
REPTILES							
Alligator, American	*Alligator mississippiensis*	Southeastern U.S.A	Wherever found in wild except those areas where listed as threatened as set forth below.	E	1, 11, 51, 60, 113, 134	NA	NA
Do	do	do	U.S.A. (FL and certain areas of GA and SC, as set forth in 17.42(a)(1)).	T	20, 47, 51, 60, 134	NA	17.42(a)
Do	do	do	U.S.A. (LA and TX).	T(S/A)	11, 47, 51, 60, 113, 134	NA	17.42(a)
Do	do	do	In captivity wherever found.	T(S/A)	11, 47,51	NA	17.42(a)
Alligator, Chinese	*Alligator sinensis*	China	Entire	E	15	NA	NA
Anole, Culebra Island giant	*Anolis roosevelti*	U.S.A. (PR: Culebra Island)	do	E	25	17.95(c)	NA
Boa, Jamaican	*Epicrates subflavus*	Jamaica	do	E	3	NA	NA
Boa, Mona	*Epicrates monensis monensis*	U.S.A. (PR)	do	T	33	17.95(c)	NA
Boa, Puerto Rico	*Epicrates inornatus*	do	do	E	2	NA	NA
Boa, Round Island [no common name]	*Casarea dussumieri*	Indian Ocean: Mauritius	do	E	88	NA	NA
Boa, Round Island [no common name]	*Bolyeria multocarinata*	do	do	E	88	NA	NA
Boa, Virgin Islands tree	*Epicrates monensis granti*	U.S. and British Virgin Islands	do	E	2, 86	NA	NA
Caiman, Apaporis River	*Caiman crocodilus apaporiensis*	Colombia	do	E	15	NA	NA
Caiman, black	*Melanosuchus niger*	Amazon basin	do	E	15	NA	NA
Caiman, broad-snouted	*Caiman latirostris*	Brazil, Argentina, Paraguay, Uruguay	do	E	15	NA	NA
Caiman, Yacare	*Caiman crocodilus yacare*	Bolivia, Argentina, Peru, Brazil	do	E	3	NA	NA
Chuckwalla, San Esteban Island	*Sauromalus varius*	Mexico	do	E	88	NA	NA
Crocodile, African dwarf	*Osteolaemus tetraspis tetraspis*	West Africa	do	E	15	NA	NA
Crocodile, African slender-snouted	*Crocodylus cataphractus*	Western and central Africa	do	E	5	NA	NA
Crocodile, American	*Crocodylus acutus*	U.S.A. (FL), Mexico, South America, Central America, Caribbean.	do	E	10, 87	17.95(c)	NA
Crocodile, Ceylon mugger	*Crocodylus palustris kimbula*	Sri Lanka	do	E	15	NA	NA
Crocodile, Congo dwarf	*Osteolaemus tetraspis osborni*	Congo River drainage	do	E	15	NA	NA
Crocodile, Cuban	*Crocodylus rhombifer*	Cuba	do	E	3	NA	NA
Crocodile, Morelet's	*Crocodylus moreletii*	Mexico, Belize, Guatemala	do	E	3	NA	NA
Crocodile, mugger	*Crocodylus palustris palustris*	India, Pakistan, Iran, Bangladesh	do	E	15	NA	NA
Crocodile, Nile	*Crocodylus niloticus*	Africa	do	E	3	NA	NA
Crocodile, Orinoco	*Crocodylus intermedius*	South America: Orinoco River Basin	do	E	3	NA	NA
Crocodile, Philippine	*Crocodylus novaeguineae mindorensis*	Philippine Islands	do	E	15	NA	NA
Crocodile, saltwater (=estuarine)	*Crocodylus porosus*	Southeast Asia, Australia, Papua-New Guinea, Pacific Islands.	Entire, except Papua-New Guinea.	E	87	NA	NA
Crocodile, Siamese	*Crocodylus siamensis*	Southeast Asia, Malay Peninsula	Entire	E	15	NA	NA
Gavial (=gharial)	*Gavialis gangeticus*	Pakistan, Burma, Bangladesh, India, Nepal.	do	E	3, 15	NA	NA
Gecko, day	*Phelsuma edwardnewtoni*	Indian Ocean: Mauritius	do	E	3	NA	NA
Gecko, Monito	*Sphaerodactylus micropithecus*	U.S.A. (PR)	do	E	125	17.95(c)	NA
Gecko, Round Island day	*Phelsuma guentheri*	Indian Ocean: Mauritius	do	E	3	NA	NA
Gecko, Serpent Island	*Cyrtodactylus serpensinsula*	do	do	T	129	NA	[illegible]

Species: Common name	Species: Scientific name	Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Iguana, Acklins ground	*Cyclura rileyi nuchalis*	West Indies: Bahamas	......do	T	129	NA	NA
Iguana, Allen's Cay	*Cyclura cychlura inornata*	......do	......do	T	129	NA	NA
Iguana, Andros Island ground	*Cyclura cychlura cychlura*	......do	......do	T	129	NA	NA
Iguana, Anegada ground	*Cyclura pinguis*	West Indies: British Virgin Islands (Anegada Islands).	......do	E	3	NA	NA
Iguana, Barrington land	*Conolophus pallidus*	Ecuador (Galapagos Islands)	......do	E	3	NA	NA
Iguana, Cayman Brac ground	*Cyclura nubila caymanensis*	West Indies: Cayman Islands	......do	T	129	NA	NA
Iguana, Cuban ground	*Cyclura nubila nubila*	Cuba	Entire (excluding population introduced in Puerto Rico).	T	129	NA	NA
Iguana, Exuma Island	*Cyclura cychlura figginsi*	West Indies: Bahamas	Entire	T	129	NA	NA
Iguana, Fiji banded	*Brachylophus fasciatus*	Pacific: Fiji, Tonga	......do	E	88	NA	NA
Iguana, Fiji crested	*Brachylophus vitiensis*	Pacific: Fiji	......do	E	88	NA	NA
Iguana, Grand Cayman ground	*Cyclura nubila lewisi*	West Indies: Cayman Islands	......do	E	129	NA	NA
Iguana, Jamaican	*Cyclura collei*	West Indies: Jamaica	......do	E	129	NA	NA
Iguana, Mayaguana	*Cyclura carinata bartschi*	West Indies: Bahamas	......do	T	129	NA	NA
Iguana, Mona ground	*Cyclura stejnegeri*	U.S.A. (PR: Mona Island)	......do	T	33	17.95(c)	NA
Iguana, Turks and Caicos	*Cyclura carinata carinata*	West Indies: Turks and Caicos Islands	......do	T	129	NA	NA
Iguana, Watling Island ground	*Cyclura rileyi rileyi*	West Indies: Bahamas	......do	E	129	NA	NA
Iguana, White Cay ground	*Cyclura rileyi cristata*	......do	......do	T	129	NA	NA
Lizard, blunt-nosed leopard	*Gambelia (=Crotaphytus) silus*	U.S.A. (CA)	......do	E	1	NA	NA
Lizard, Coachella Valley fringe-toed	*Uma inornata*	......do	......do	T	105	17.95(c)	NA
Lizard, Hierro giant	*Gallotia simonyi simonyi*	Spain (Canary Islands)	......do	E	144	NA	NA
Lizard, Ibiza wall	*Podarcis pityusensis*	Spain (Balearic Islands)	......do	T	144	NA	NA
Lizard, Island night	*Xantusia (=Klauberina) riversiana*	U.S.A. (CA)	......do	T	26	NA	NA
Lizard, St. Croix ground	*Ameiva polops*	U.S.A. (VI)	......do	E	24	17.95(c)	NA
Monitor, Bengal	*Varanus bengalensis*	Iran, Iraq, India, Sri Lanka, Malaysia, Afghanistan, Burma, Vietnam, Thailand.	......do	E	15	NA	NA
Monitor, desert	*Varanus griseus*	North Africa to Neareast, Caspian Sea through U.S.S.R. to Pakistan, Northwest India.	......do	E	15	NA	NA
Monitor, Komodo Island	*Varanus komodoensis*	Indonesia (Komodo, Rintja, Padar, and western Flores Island).	......do	E	15	NA	NA
Monitor, yellow	*Varanus flavescens*	West Pakistan through India to Bangladesh.	......do	E	15	NA	NA
Python, Indian	*Python molurus molurus*	Sri Lanka and India	......do	E	15	NA	NA
Rattlesnake, Aruba Island	*Crotalus unicolor*	Aruba Island (Netherland Antilles)	......do	T	129	NA	NA
Rattlesnake, New Mexican ridge-nosed	*Crotalus willardi obscurus*	U.S.A. (NM), Mexico	......do	T	43	17.95(c)	NA
Skink, Round Island	*Leiolopisma telfairi*	Indian Ocean: Mauritius	......do	T	129	NA	NA
Snake, Atlantic salt marsh	*Nerodia fasciata taeniata*	U.S.A. (FL)	......do	T	30	NA	NA
Snake, eastern indigo	*Drymarchon corais couperi*	U.S.A. (AL, FL, GA, MS, SC)	......do	T	32	NA	NA
Snake, San Francisco garter	*Thamnophis sirtalis tetrataenia*	U.S.A. (CA)	......do	E	1	NA	NA
Tartaruga	*Podocnemis expansa*	South America: Orinoco and Amazon River basins.	......do	E	3	NA	NA
Terrapin, river (=Tuntong)	*Batagur baska*	Malaysia, Bangladesh, Burma, India, Indonesia.	......do	E	3	NA	NA
Tomistoma	*Tomistoma schlegelii*	Malaysia, Indonesia	......do	E	15	NA	NA
Tortoise, angulated	*Geochelone yniphora*	Malagasy Republic (=Madagascar)	......do	E	15	NA	NA
Tortoise, Bolson	*Gopherus flavomarginatus*	Mexico	......do	E	46	NA	NA
Tortoise, desert	*Scaptochelys (=Gopherus) agassizii*	U.S.A. (UT, AZ, CA, NV); Mexico	Beaver Dam [illegible]pe, U[illegible]	T	103	17.95(c)	NA

REFERENCE NO. 20

00420
02-8804-02

NUS CORPORATION AND SUBSIDIARIES TELECON NOTE

CONTROL NO: 02-8804-02	DATE: 2-16-89	TIME: 0930

DISTRIBUTION: Info. on Arthur Kill, Raritan Bay, and the Rahway River.

BETWEEN: Mr. Dellemo	OF: Woodbridge Health Dept.	PHONE: (201) 634-4500 ex. 207

AND: G. A. Calabrese

DISCUSSION:

No swimming is permitted in the Arthur Kill. Mr. Dellomo noted that there is a high mercury content in the Arthur Kill. Fishing is permitted, but they (people fishing) are told that eating the fish is at the persons own risk. According to the best of Mr. Dellomo's knowledge, no recreational purposes are known to him. The A.K. is a polluted river. The Raritan Bay is most likely the same, as well as the Rahway River and the tributaries of the Arthur Kill.

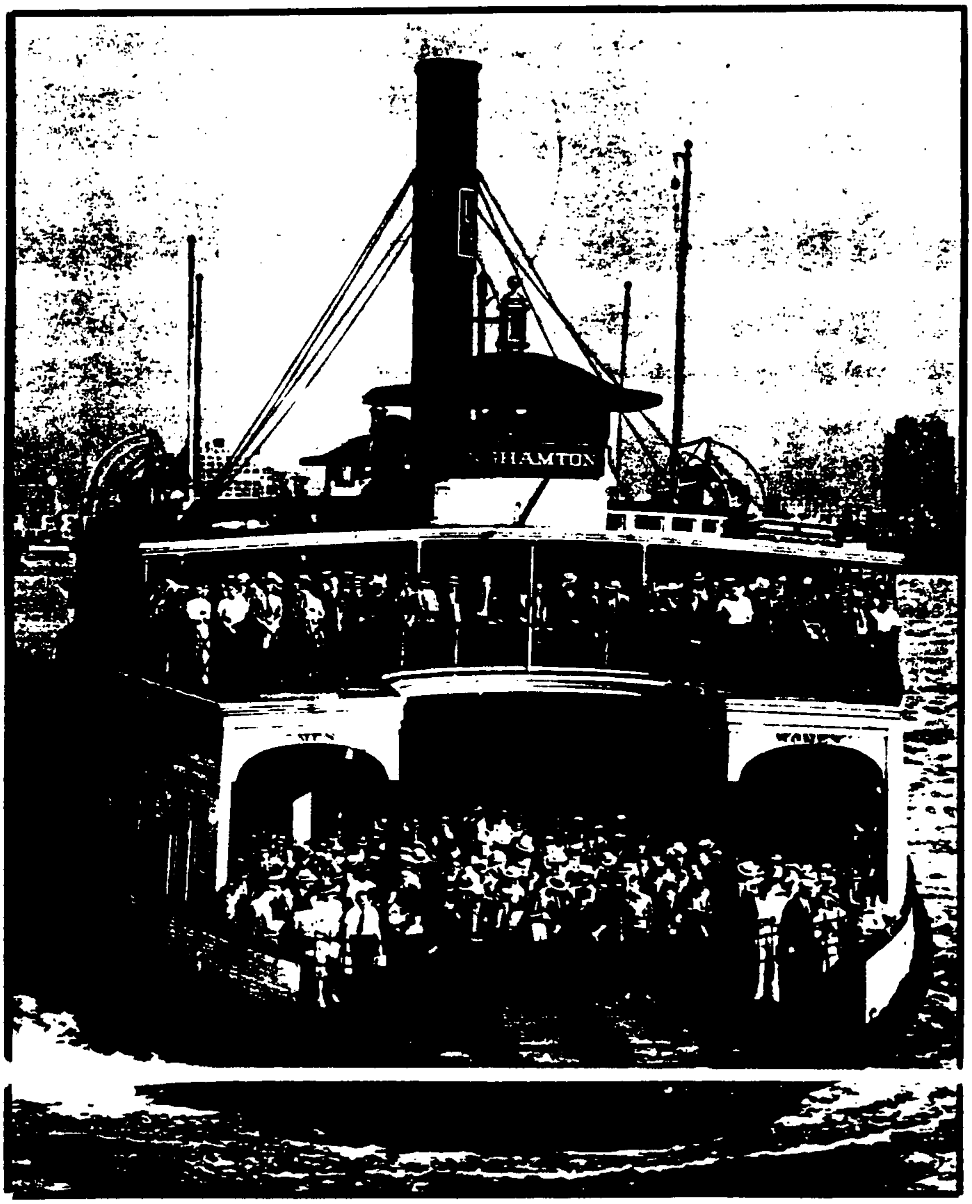
ACTION ITEMS:

NUS 067 REVISED 0685

REFERENCE NO. 21

New Jersey & National Registers of Historic Places

as of December 31, 1984



Office of New Jersey Heritage

N.J. Department of Environmental Protection • Division of Parks and Forestry

STATE OF NEW JERSEY

THOMAS H. KEAN, GOVERNOR

DEPARTMENT OF ENVIRONMENTAL PROTECTION

ROBERT E. HUGHEY, COMMISSIONER

This publication has been financed in part by federal funds from the National Park Service, U. S. Department of the Interior, through the Office of New Jersey Heritage.

cover: Ferryboat Binghamton,
Edgewater Borough, Bergen County

NEW JERSEY & NATIONAL REGISTERS OF HISTORIC PLACES

AS OF DECEMBER 31, 1984

OFFICE OF NEW JERSEY HERITAGE

DIVISION OF PARKS AND FORESTRY

DEPARTMENT OF ENVIRONMENTAL PROTECTION

CN 404

TRENTON, NEW JERSEY 08625

REFERENCE NO. 22

40074-A1-EI-2

69-805

GEOSTAT MAP & TRAVEL CENTERS

11 $4.95

Newark

N. J.—N. Y.—PA.

1:250 000-scale map of

Atlantic Coast Ecological Inventory

Produced by
U. S. FISH AND WILDLIFE SERVICE
1980

TERRESTRIAL ORGANISMS

Shown in BROWN; species with special status shown in RED-(F) or (S) indicates species protected by Federal or State Legislation (see text)

SYMBOL SPECIES

PLANTS (301-350)

301 Eastern hemlock
302 Spleenwort (S)
303 Spider lily (S)
304 Pond bush (S)
305 Watermilfoil (S)
306 Hooded pitcher plant (S)
307 Tree
308 Prickly pear cactus (S)
309 Trailing arbutus (S)
310 Eastern bumelia
311 Pitcher plant
312 Baldcypress
313 Redbay
314 Seaside alder
315 Box huckleberry
316 Purple fringeless orchid
317 Pink lady's slipper
318 Ebony spleenwort (S)
319 Orchids (S)
320 Golden club (S)
321 Florida beargrass
322 East-coast coontie
323 Fall-flowering ixia
324 Jackson-vine
325 Spoon-flower
326 Curtiss milkweed
327 Sea lavender
328 Hand fern
329 Needle palm
330 Yellow squirrel-banana
331 Beach creeper
332 Florida coontie
333 Four-petal pawpaw
334 Bird's nest spleenwort
335 Burrowing four-o'clock
336 Beach star
337 Silver palm
338 Dancing lady orchid
339 Tamarindillo
340 Fuch's bromeliad
341 Everglades peperomia
342 Buccaneer palm
343 Slender spleenwort
344 Pineland jacquemontia
345 Mahogany mistletoe
346 Florida thatch
347 Twisted air plant
348 Long's bittercress
349 Venus's flytrap

INVERTEBRATES (351-400)

351 Monarch butterfly
352 Zebra butterfly

BIRDS (401-600)

SHOREBIRDS (401-430)

401 Shorebirds
402 Terns
403 Gulls
404 Forster's tern
405 Arctic tern
406 Least tern (S)
407 Roseate tern (S)
408 Common tern
409 Great black-backed gull
410 Herring gull
411 Laughing gull
412 Black skimmer (S)
413 Turnstones
414 Plovers
415 Piping plover
416 American oystercatcher (S)

WADING BIRDS (431-460)

431 Wading birds
432 Herons
433 Egrets
434 Rails
435 Ibises
436 Bitterns
437 Great blue heron (S)
438 Wood ibis (S)
439 Anhinga
440 Little blue heron (S)
441 Yellow-crowned night heron (S)
442 Black-crowned night heron
443 Florida sandhill crane (S)
444 Louisiana heron (S)
445 Limpkin (S)
446 Roseate spoonbill (S)
447 Snowy egret (S)
448 Magnificent frigate-bird (S)
449 Reddish egret (S)
450 Clapper rail

AQUATIC ORGANISMS

Shown in BLUE; species with special status shown in RED-(F) or (S) indicates species protected by Federal or State Legislation (see text)

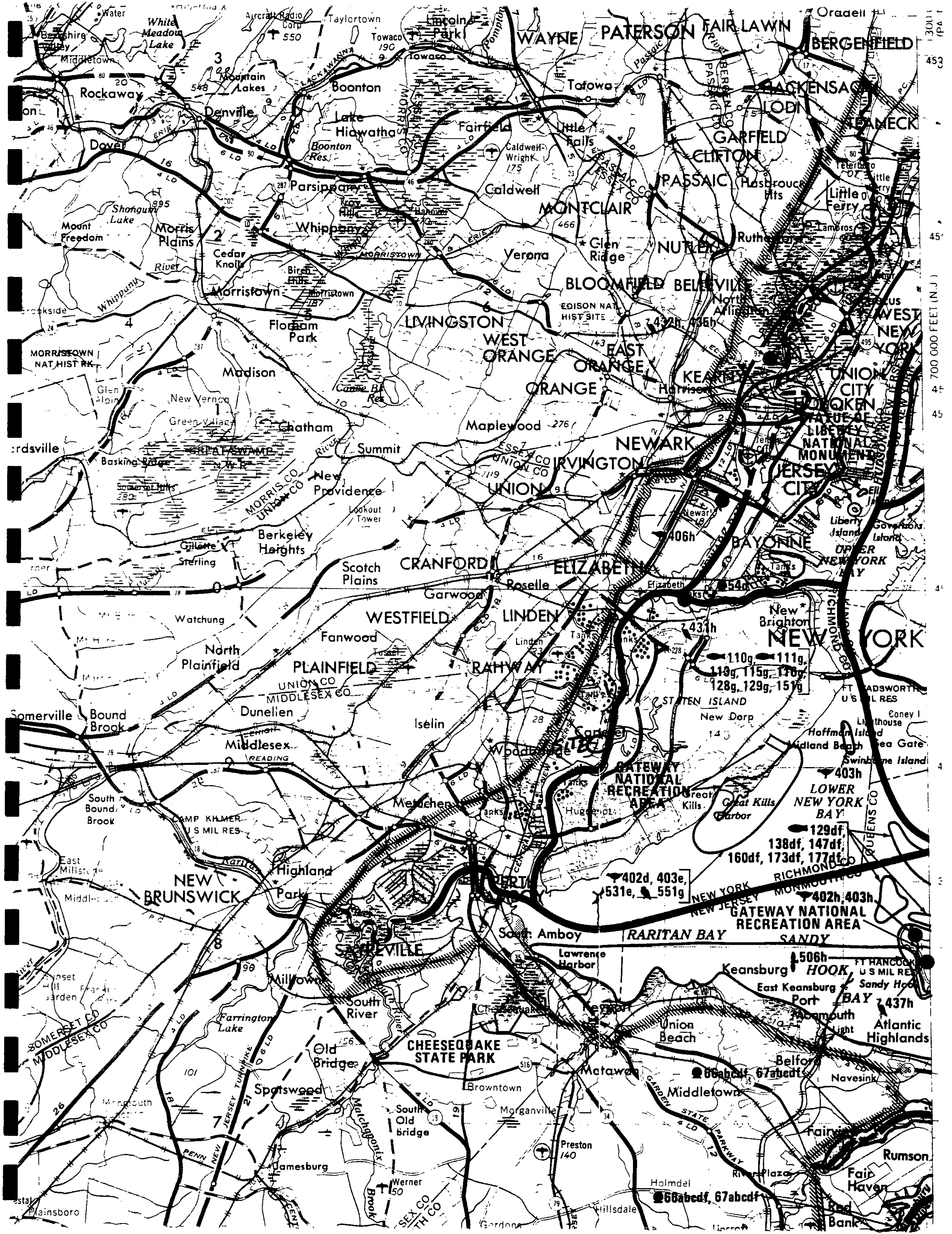
SYMBOL SPECIES

PLANTS (1-50)

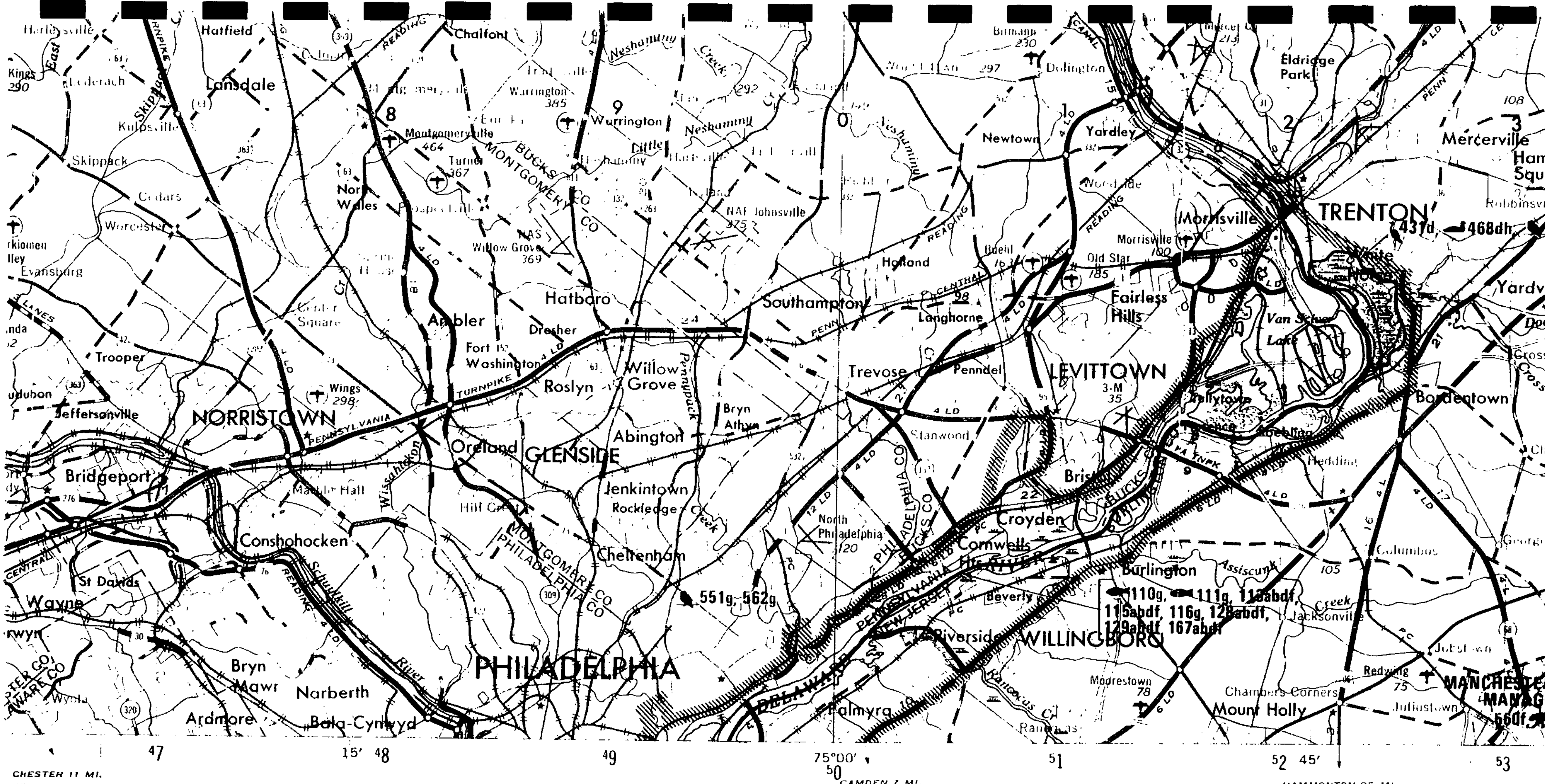
1 Irish moss
2 Rockweed

INVERTEBRATES (51-100)

51 Crabs
52 Mussels
53 Oysters
54 Scallops



Berkshire Valley
White Meadow Lake
Taylortown
Towaco
Lincoln Park
WAYNE
PATERSON
FAIR LAWN
BERGENFIELD
Middletown
Rockaway
Mountain Lakes
Boonton
Totowa
HACKENSACK
LODI
Denville
Lake Hiawatha
Fairfield
Little Falls
TEANECK
GARFIELD
Dover
Boonton Res
CLIFTON
Parsippany
Caldwell
PASSAIC
Hasbrouck Hts
Little Ferry
Shongum Lake
Mount Freedom
Morris Plains
MONTCLAIR
Whippany
Cedar Knolls
Verona
Glen Ridge
NUTLEY
Morristown
BLOOMFIELD
BELLEVILLE
North Arlington
EDISON NAT HIST SITE
Florham Park
LIVINGSTON
WEST ORANGE
EAST ORANGE
WEST NEW YORK
MORRISTOWN NAT HIST PK
Madison
ORANGE
KEARNY
Harrison
UNION CITY
HOBOKEN
New Vernon
Chatham
Maplewood
STATUE OF LIBERTY NATIONAL MONUMENT
Green Village
NEWARK
GREAT SWAMP N W R
Summit
Basking Ridge
IRVINGTON
JERSEY CITY
New Providence
UNION
ESSEX CO
UNION CO
MORRIS CO
Lookout Tower
Liberty Island
Governors Island
Berkeley Heights
BAYONNE
UPPER NEW YORK BAY
Gillette
Sterling
Scotch Plains
CRANFORD
ELIZABETH
Roselle
Garwood
Watchung
WESTFIELD
LINDEN
New Brighton
NEW YORK
Fanwood
North Plainfield
PLAINFIELD
RAHWAY
MIDDLESEX CO
STATEN ISLAND
Somerville
Bound Brook
Dunellen
Iselin
New Dorp
Middlesex
Hoffman Island
Midland Beach
Sea Gate
Swinburne Island
GATEWAY NATIONAL RECREATION AREA
South Bound Brook
CAMP KILMER U S MIL RES
Metuchen
Great Kills
Great Kills Harbor
LOWER NEW YORK BAY
East Millstone
NEW BRUNSWICK
Highland Park
RARITAN BAY
South Amboy
SAYREVILLE
Lawrence Harbor
Keansburg
HOOK
Sandy Hook
Milltown
East Keansburg
Port Monmouth
Atlantic Highlands
South River
Farrington Lake
Union Beach
CHEESEQUAKE STATE PARK
Old Bridge
Matawan
Belford
Navesink
Spotswood
Browntown
Middletown
South Old Bridge
Morganville
Preston
Jamesburg
Rumson
Fair Haven
Holmdel
Plainsboro
Hillsdale
Red Bank
SOMERSET CO
NEW JERSEY TURNPIKE
GARDEN STATE PARKWAY
700 000 FEET (N.J.)



Scale 1:250,000

5 0 5 10 15 20 Statute Miles

5 0 5 10 15 20 25 30 Kilometers

5 0 5 10 15 Nautical Miles

TRANSVERSE MERCATOR PROJECTION

BLACK NUMBERED LINES INDICATE THE 10,000 METER UNIVERSAL TRANSVERSE MERCATOR GRID, ZONE 18

FOR SALE BY U. S. GEOLOGICAL SURVEY, RESTON, VIRGINIA 22092, OR DENVER, COLORADO 80225

urface
d surface
roved surface
oved surface

J.S., State (95) (29) (193)
Church: Other
ef
stream